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Power Industry

A Putman Publication | "Executive Magazines for Industry"

NOVEMBER 1957

For the Power Services Management Team

WHAT IS YOUR ATTITUDE TOWARD SALES ENGINEERS?

JUSTUS T. VOLLBRECHT, PRESIDENT
Energy Control Co., Inc., and past president ISA

seatless means savings

For nearly 50 years boiler plants in low and medium pressure ranges have been saving maintenance time and down-time thanks to dependable, trouble-free blow-down service from Yarway Seatless Blow-Off Valves.

The reason is simple. One of the commonest sources of blow-off valve trouble is eliminated. *There is no seat to score, wear, clog or leak.*

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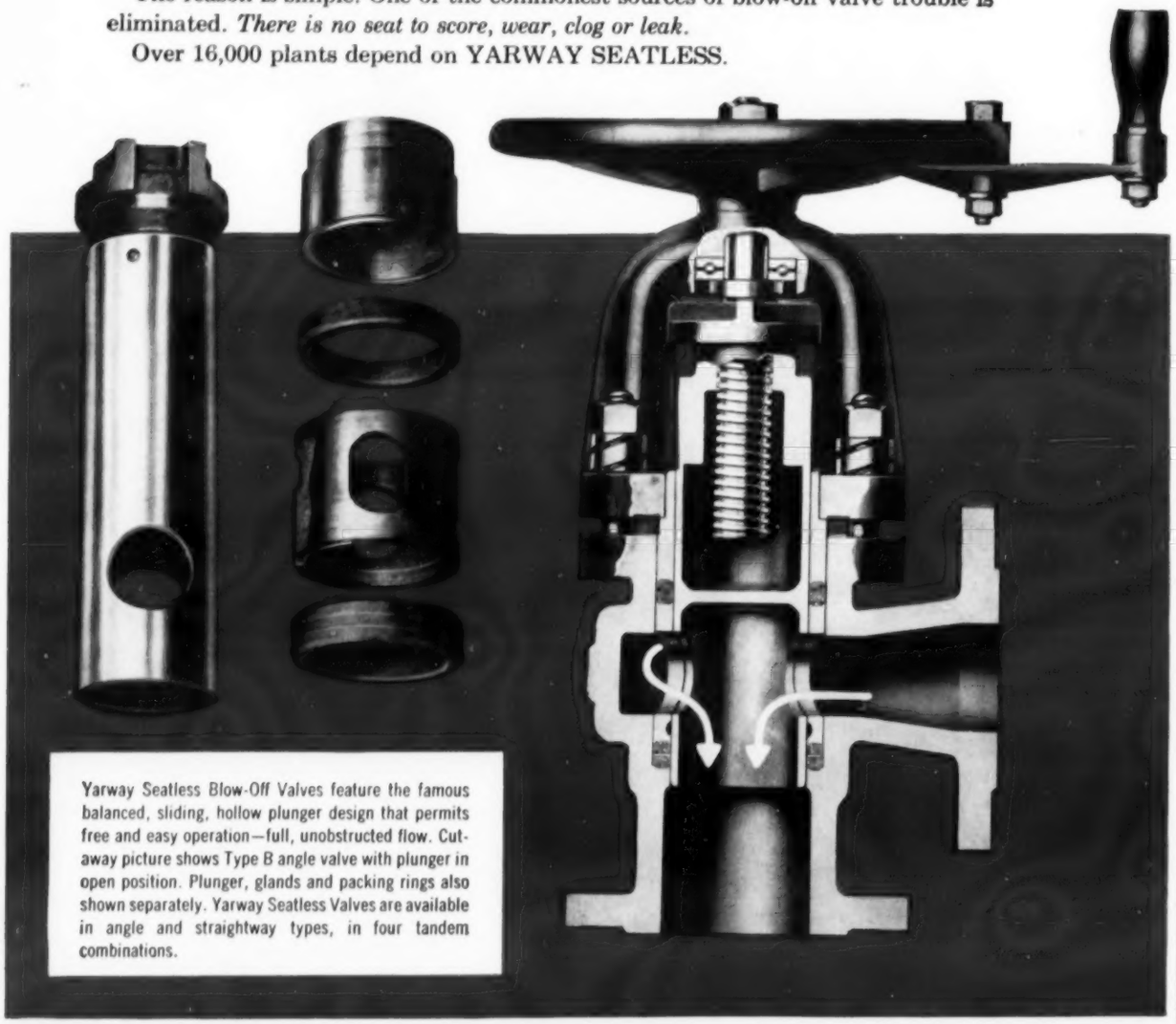

Yarway Seatless Blow-Off Valves feature the famous balanced, sliding, hollow plunger design that permits free and easy operation—full, unobstructed flow. Cut-away picture shows Type B angle valve with plunger in open position. Plunger, glands and packing rings also shown separately. Yarway Seatless Valves are available in angle and straightway types, in four tandem combinations.

For information on Yarway Seatless Valves, sizes, materials, pressures, etc., write

YARNALL-WARING COMPANY 100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY SEATLESS ...a good way to specify blow-off valves

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Power Industry

with which is combined
Industrial Power and Industry Power

Shepard-Benning Building
St. Joseph, Mich., YUkon 3-5515

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Advertising Representation
will be found on page 51

The power services include the production, transmission, and application of all forms of energy—steam, electricity, mechanical power, pneumatic, hydraulic—and engineering maintenance for the power services in the following:

- Public Utilities
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  - Waterworks
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A PUTMAN PUBLICATION

Power Industry

FOR THE POWER SERVICES MANAGEMENT TEAM

VOLUME 73 NO. 6 NOVEMBER 1957

what is your attitude toward sales engineers? 11
One of the nation's leading manufacturer's representatives tells how to get your best "bargain" from the salesmen who call on you.

basic boiler plant design 12
Three basic, workable designs for boiler plants in 100,000 to 450,000 lb/hr capacity range using field-erected boilers.

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Parallel operation between plant generating equipment and purchased power for peaking requirements is maintained with Cordon breakers.

analyzer cuts engine maintenance costs 16
Portable instruments analyze ignition, vibration, pressure inside running engines to pinpoint maintenance troubles.

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Perth Amboy Refinery uses an epoxy compound to protect piping and pumping equipment when salt water is used as coolant.

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Vinyl coatings on chemical storage tanks at Davison Chemical Co. last three times longer than conventional coatings formerly used.

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Battery of six filters in Denmark's largest power station helps cut oil, labor, and filter costs.

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When explosion demolished hospital boiler room, Cleaver-Brooks boiler was installed and in operation within 11 hours.

Power Pac developed for heating titanium 46
The Martin Co. achieves greater efficiency in resistance heating titanium with Power Pac unit.

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Acme ACME Electric
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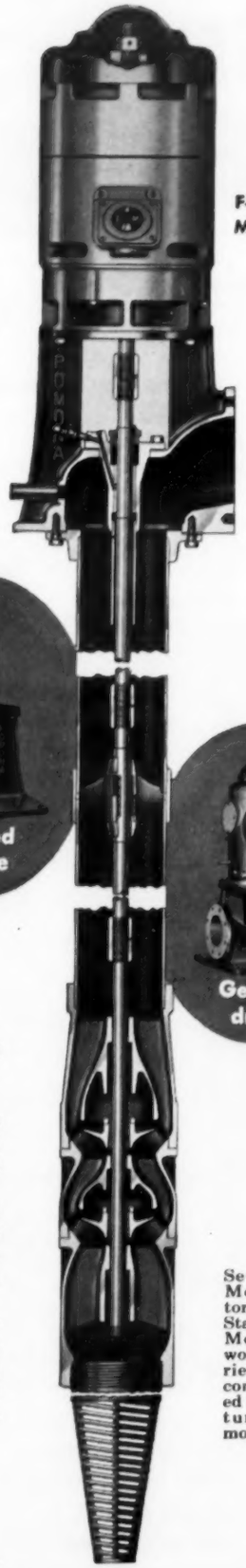
You'll want to look into this pump



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NEW F-M POMONA WATER-LUBRICATED TURBINE PUMP

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Ask for details on this new F-M Pomona pump for raw water supply, air conditioning, refrigeration, cooling towers, sump pumping, dewatering, etc. Contact your Fairbanks-Morse Sales Engineer today. Ask for new illustrated Bulletin 6957-1. Or write Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill., Dept. IP-11.

Seven Fairbanks-Morse pump factories in the United States, Canada and Mexico build the world's greatest variety of hydraulic combinations offered by any manufacturer of liquids-moving machinery.

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PI news

Computer service offered to business, industry now

Scientific computation and mathematical analysis service for businesses and industrial organizations is now offered by Ramo-Wooldridge Corp., Los Angeles. Consulting in computer applications and digital computing service, including numerical analysis, programming, and equipment rental, will be offered.

$49 million Mammoth Pool power project slated

Construction of a new dam, power house, and water storage reservoir on the upper San Joaquin river near Fresno, Cal., will add 126,000 kw generating capacity to Southern California Edison's Big Creek chain of lakes, dams, and power houses. The Mammoth Pool project, says James F. Davenport, executive vice president, will add 25% to the production capacity of what has already been called 'the hardest working water in the world.'

New technique measures exact stresses in piping

A Philadelphia engineer, John W. Soule, has recently developed a new mathematical technique making application of electrical laws to mechanical problems in piping systems practical for the first time. The electric analogy method—now purged of stumbling blocks through use of the new technique — is used to analyze stresses in high-temperature, high-pressure piping for power plants, refineries, and chemical plants even before installation. New technique was devised by Soule, mechanical design engineer with United Engineers, Philadelphia, and presented in a recent paper before ASME.

AEC names new reactor advisory group

Nine members have been selected for a new 15-member statutory Advisory Committee on Reactor Safeguards says AEC's Chairman Lewis L.

(continues on page 6)

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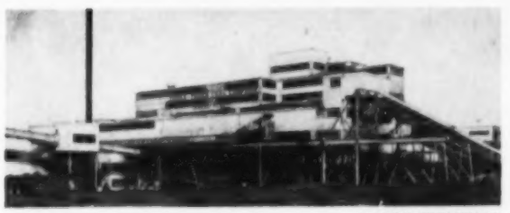
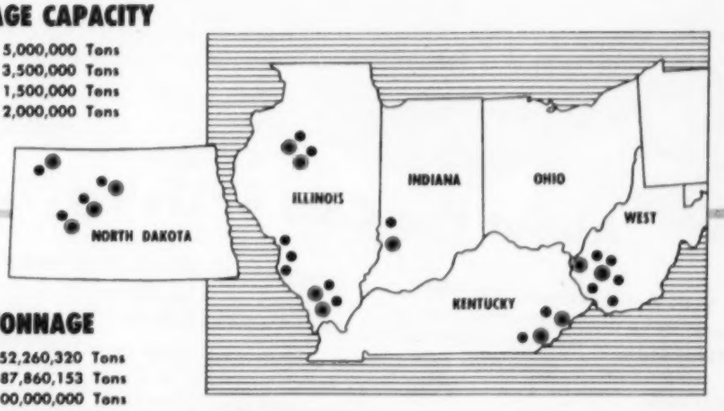


CEREDO, WEST VIRGINIA

STRATEGICALLY LOCATED MINES

ANNUAL TONNAGE CAPACITY

Illinois	5,000,000 Tons
West Virginia	3,500,000 Tons
Kentucky	1,500,000 Tons
North Dakota	2,000,000 Tons



RESERVES OVER 500,000,000 TONS

RESERVE TONNAGE

Illinois	152,260,320 Tons
West Virginia	187,860,153 Tons
Kentucky	100,000,000 Tons
North Dakota	108,309,828 Tons

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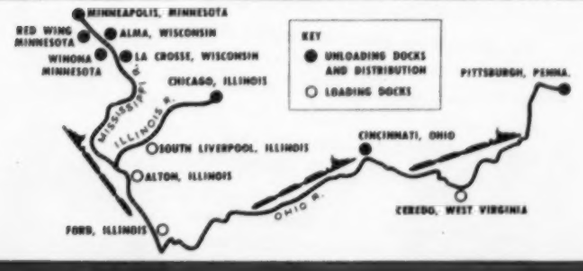

Shipping dollars are being saved by TRUAX-TRAER water transportation from mines and preparation plants. Combining this advantage with rail provides important economies worth looking into.

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About the Cost of Living . . . with Steam Traps

WHEN YOU specify steam traps, what could possibly be more important than *the cost of living with them* — production cost . . . steam cost . . . downtime cost . . . repair cost.

No steam traps manufactured have ever provided greater equipment operating efficiency or lower trap maintenance cost than Armstrongs.

Consider the experiences of these companies:

"30% Greater Output from platen presses since installing Armstrong Traps" — rubber processor.

"$8000 Annual Fuel Saving since replacing 600 traps with Armstrong" — metal processor.

"30% Less Downtime for repairs with Armstrong Traps" — food processor.

"$25,000 Trap Maintenance Saving every year since installing 4000 Armstrong Traps" — major chemical plant.

You may well ask, "Can there really be so big a difference in steam trap performance?" The answer is: These are typical experiences of people who have compared Armstrong trap performance — not for a month or a year, but over periods of 2, 5 and even 10 years or more.

The Armstrong trap has certain fundamental advantages, including:

No Steam Loss — the valve is always water-sealed.

Large air-venting capacity — air is automatically discharged along with condensate.

Long-life parts — hardened chrome steel valve and seat — all other parts corrosion-resistant stainless. Absolutely nothing to stick, bind, clog or collapse. Not affected by ordinary dirt and scale.

Unconditionally guaranteed to satisfy. It takes an awfully good product to carry such a guarantee.

Steam traps can have such a big effect on plant operating efficiency, they are worth more than casual consideration. Let your Armstrong Factory Representative answer your questions. There is no obligation. Call him or write:

ARMSTRONG MACHINE WORKS
8207 Maple Street • Three Rivers, Mich.

Do you have "The Steam Trap Book"? — 44 pages of useful data on trap sizing, calculation of condensate loads, installation and maintenance. Free on request.

ARMSTRONG STEAM TRAPS

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P/ news

. . . starts on page 4

Strauss. New committee was formed after recent amendment to Atomic Energy Act by 85th Congress, replacing old group with the same name. Committee's job is to review and report on safety studies, advise AEC on hazards of proposed or existing reactor facilities. By law, reports will be made public.

Cleveland solves air pollution problem

Serious smoke problem plaguing many cities caused by open burning of automobile bodies in auto wrecking and salvage yards is solved in Cleveland, Ohio. 30 auto wrecking yards in Cleveland process 50,000 automobiles yearly, burning combustibles before turning them over to steel mills for scrap. Problem was in designing an incinerator to comply with Cleveland's stiff Smoke Abatement Ordinance, yet economically feasible for auto wreckers to build. Problem was licked when one wrecker came up with an improvised incinerator which worked beautifully, yet burning costs only $5 per car. Now Cleveland has six automobile body incinerators in use.

Ever wonder what a "typical" company president looks like?

The "typical" company president — among a group of 335 recently surveyed by the American Management Association — is an energetic man who works 10 or 15 hours beyond his company's normal work week, spends 6 or 7 weeks a year traveling on business, and has a hard time finding enough hours for his wife and two or three children, golf, reading, and community service. He is about 50 years old, earns an average of $68,000 a year, owns his own home and two or more cars.

Chicago will host 1958's Atomfair in March

The atomic industry will stage its major 1958 trade show next March 17-21 at Chicago's International Amphitheatre. Show

will feature current developments in the industrialization of the atom. Held in conjunction with the 1958 Nuclear Congress, the 1958 show will be known as the Atomfair of the Atomic Industrial Forum.

FROM THE MAILBAG . . .

Amann cited

"I must agree with Mr. Joseph Amann that a turnover of 17% of the engineers in the airplane industry is proof positive of poor employer-employee relations. Having worked and associated with graduate engineers in industry, my experience is analogous to what Mr. Amann has mentioned. There exists low morale, dissatisfaction, frustration, lack of professional recognition, too much routine work, lack of security, and most important, inadequate pay.

An individual cannot bargain successfully. An employer can and will promise many things when hiring an engineer but the promises turn out to be false and an individual has only to complain and he is considered a troublemaker, which can result in discharge for petty reasons. The past employer's recommendations can be used effectively when the individual is searching for another position."

Joseph J. Adamo
Detroit 24, Mich.

Believes engineers worth more

"Your article featuring Mr. Harry Rains and Mr. Joseph Amann on "Unions for Engineers" was very well presented. We felt that it was most timely in view of recent articles in various newspapers throughout the country on the organizing of engineers in the U. S. We feel that an article of this type actually attracts more reading than any other current news interest and we certainly concur with Mr. Rains on his phase of the discussion, but also believe if industry is to attract the proper quantity of qualified engineers, and if industry is to have the engineers retain their individual status, the monetary considerations now in effect will have to be made better to attract the right potential engineers. It is hoped that in the near future,

IS SPACE A FACTOR IN YOUR BOILER NEEDS ?

Here's a quick easy way for you to make your own preliminary plans for maximum steam capacity in minimum space.

FREE 1/4 INCH SCALE TEMPLATE OF COMPLETE VAPOR MODULATIC WATER TUBE BOILER LINE MAKES BOILER NEED PLANNING SIMPLE

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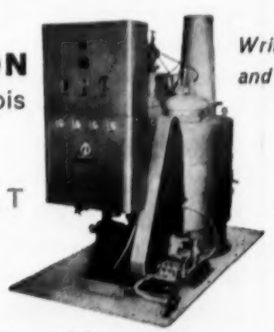
VAPOR HEATING CORPORATION
80 East Jackson Boulevard · Chicago 4, Illinois



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THE WORLD'S MOST COMPACT POWER PACKAGE

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your magazine can discuss this general topic with other leading authorities in this field."

J. R. Hooper
Chief Engineer
Simmons Co.
New York, N.Y.

"Just a note to say we like your new size much better than the old. We maintain a file of pertinent articles and the old size was quite difficult to fit into the files. . ."

E. H. O'Neal
Mechanical Engineer
Florida Power & Light Co.
New York, N. Y.

The editors of POWER INDUSTRY welcome your comments. Where space permits, we'll continue to print as many comments as we can. Let us hear from you!

New development in valve disc treatment

New development in treatment of valve discs, promoting valves into extremely high-service brackets is announced by Carl H. Morken, vice president, Kennedy Valve Mfg. Co. In tests, valves equipped with treated discs and a new packing material have completed more than 15,000 cycles of operation at 18 foot pounds closing torque on 150 psi saturated steam lines without sign of failure and without repacking.

Ceramic magnets for dc motor fields

Ceramic permanent magnets can now be used in place of electro-magnets for dc motor fields. "Because these powerful new magnets will not become demagnetized when opposed by powerful armature fields, they are now practical for use in dc motors of all sizes," says James R. Ireland, director of research and engineering at Indiana Steel Products Co., Valparaiso, Ind.

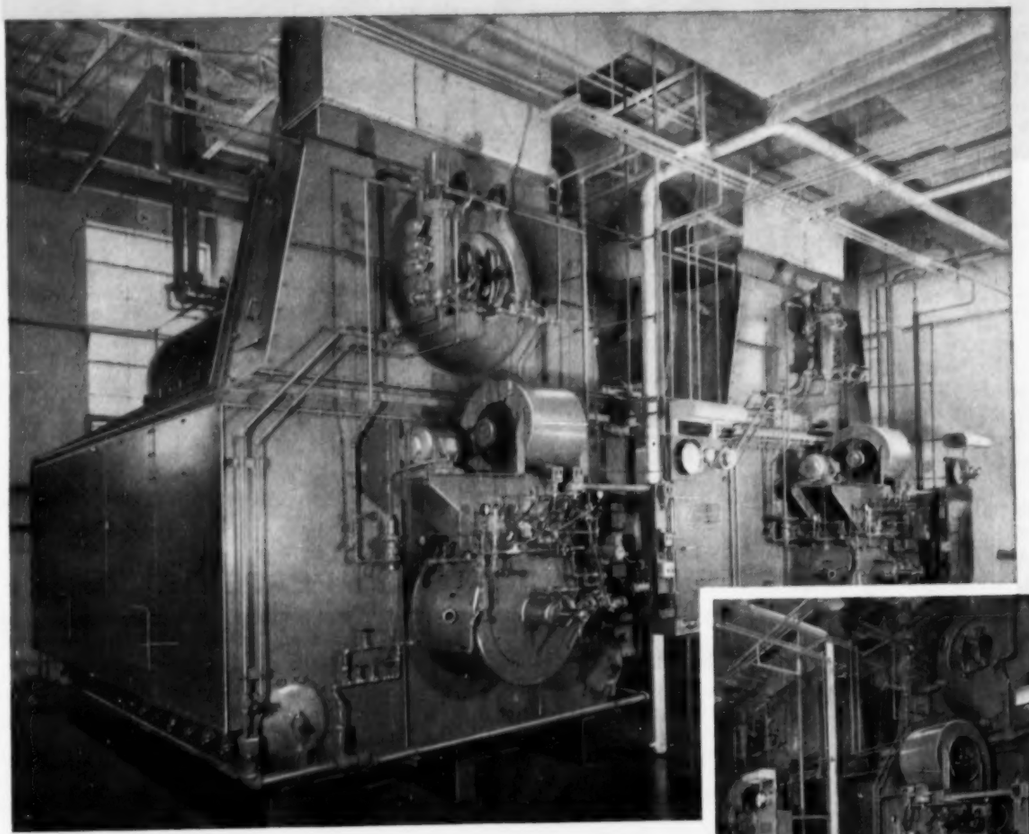
Steam gets important role in missile defense program

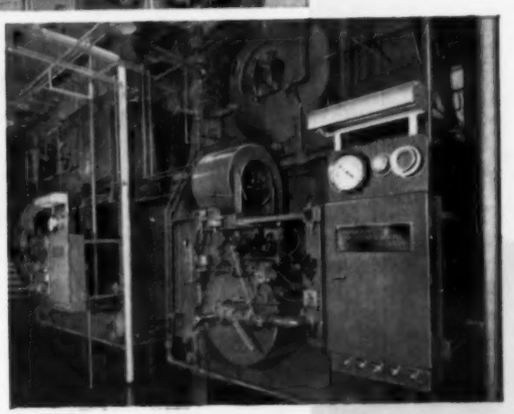
Steam will assume an important role in development of this country's guided missile defense

FOR UNFAILING, ECONOMICAL SERVICE,

WICKES Type A, shop-assembled

specified for the Edward W. Sparrow





Wickes Type-A Steam Generators combine custom engineering and shop-assembly to give you economical "packaged power" to exactly meet the load requirement. The entire unit is shipped complete ready to set on your foundation and installation can be made with minimum interruption of your production schedules. All necessary auxiliary equipment including trimmings, soot blowers, feed water regulators and other accessories, are shop-installed leaving field installation at a minimum. From the pressure-tight casing to the oil-gas burner, Wickes type-A water tube steam generators with capacities up to 60,000 lbs. of steam per hour are designed and engineered to be the standard of quality and performance in a variety of industries.

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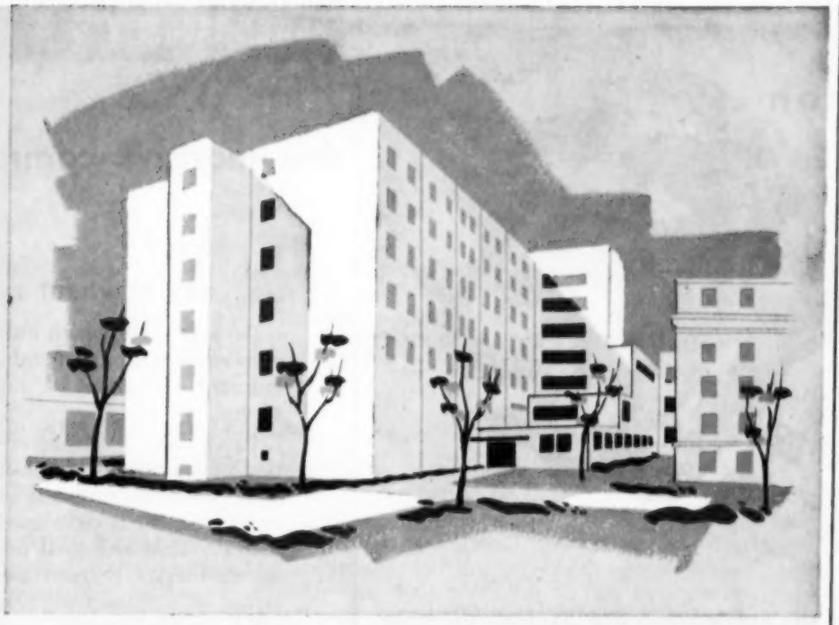
boilers are hospital



Architects sketch of new Sparrow Hospital.
Architects: O. J. Munson Associates–Lansing, Michigan.
Professional Engineers: E. Roger Hewitt Associates, Inc.–Lansing, Michigan.

One of the most important considerations in hospital construction specifications is the steam generation system, because it must give around-the-clock reliability without failure. It is significant, then, that for the Edward W. Sparrow Hospital in Lansing, Michigan, two Wickes shop-assembled Type-A Steam Generators have been installed to provide a dependable source of heat. The new units, which are housed, in a completely new boiler house, replace the original Wickes coal fired boilers. Each of these two new boilers are capable of producing 18,500 lbs. of steam per hour at an operating pressure of 125 psi. They provide 2250 square feet of heating surface and are equipped with fully automatic Wickes combination oil and gas burners. These units have a design pressure of 160 psi.

Write for our Catalog 56-1 for detailed information on Wickes Type-A Boilers, and we will also include our Bulletin 55-1 covering the complete line of Wickes Products and Facilities.

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THE WICKES BOILER CO.
DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

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program. Babcock and Wilcox Co. announces it will furnish boiler and related generating equipment at new Research and Development Center being built by Thompson Products, Inc., near Roanoke, Va. Center will use steam generated exclusively for conducting research projects including testing of components for missile system experiments with monopropellant and bipropellant fuels.

Linear programming saves power plant $20,000/year

Use of linear programming to determine power plant fuel requirements saves Duquesne Light Co., Pittsburgh, an estimated annual $20,000 in fuel costs. In a paper presented at the recent AIEE Fall meeting, A. P. Hayward and C. E. Taylor, of Duquesne, and R. H. Kerr and L. K. Kirchmayer, General Electric Co., report that the mathematical approach of linear programming used in place of previous methods indicated the large savings for Duquesne.

Grounded power station auxiliaries recommended

As the size of power stations has increased, it has become economical to increase voltage on auxiliary systems to 4160 volts, thereby raising the question of whether or not to ground the systems. At the Fall meeting of AIEE, T. H. McGreer, Westinghouse Electric Co., reports that "auxiliary systems at 4160 volts should be grounded in order to minimize multiple insulation failures. Added insurance against a first ground failure is a dividend."

Appointments, transfers kudos . . . in power industry

Iddles is Westinghouse award winner

Alfred Iddles, president of the Atomic Industrial Forum and member of the board of directors, Babcock & Wilcox Co., is 1958 winner of the George Westinghouse Medal, awarded annually by ASME.

Hoover Medal goes to Scott Turner

In recognition of many years outstanding public service, Scott Turner, New York, former di-

(continues on page 50)

Dust Particle

with a mission

. . . to pollute the atmosphere and damage valuable equipment.

Flyash control is more important today than ever before in history because of the ever increasing number of industrial plants in operation. Each type dust has its own physical, chemical and electrical properties. To design dust collection equipment to capture these particles requires basic knowledge of the importance of these variables to the overall problem.

The Aerotec Corporation is experienced in the quantitative measurement of all dust properties and is equipped to carry out these tests before a recommendation for equipment is ever made. This ability, plus the most advanced design of both mechanical and electrostatic dust collectors, makes The Aerotec Corporation the logical choice to solve your dust collection problems.

Our Project Engineers, located in most principal cities in the United States and Canada, will be happy to supply you with information and literature on either mechanical, electrostatic or series dust collectors.

Project Engineers **THE THERMIX CORPORATION** Greenwich, Conn.
(Offices in 38 principal cities)
Canadian Affiliates: T. C. CHOWN, LTD., 164 Metcalfe Ave., Westmount, Montreal 6, Que.
Manufacturers
THE AEROTEC CORPORATION
Greenwich, Conn.

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this month's comment . . . .

. . . not a wheel can turn

Do you know which industry is both the most expandable and yet the most stable in the world? It's the power industry — the part of our economy that this magazine serves.

Expandable? Whenever any single portion of production or service in our economy expands, the power industry *must immediately* expand. For example, suppose a new chemical is developed and finds a rapidly growing market. That chemical cannot be produced in quantity for its market without additional use of electricity and steam as well as compressed air, hydraulic power, and other power services. Another example: a new hotel is built . . . it immediately requires almost all the power services in order to provide housing service.

Whenever any product must be produced in increased quantity, or any public service expands — more equipment is needed to provide the power services for the expansion.

Stable? When a segment of our industrial world is at a plateau, or even declining in product demand, the power services equipment (turbines, large motors, boilers, compressors, switchgear, circuit breakers, etc.) remain in operation. They must continue to operate even when production operations are not expanding.

Not a wheel can turn in our processing and manufacturing operations without the power industry.

Not a product can be brought to the consumer without the power industry.

Not a public service can be supplied without the power industry.

No one can deny the terrific growth that the power industry has undergone in the last 15 years. And the future indicates this growth will accelerate with each year.

POWER INDUSTRY will keep its readers abreast of all the developments and changes, all the new products and techniques that will be of significance in this growth. It is organized to serve the power industry in a way that no other magazine can.

That is why this magazine is dedicated to the power industry — throughout public utilities, manufacturing and processing plants, hospitals, hotels, colleges, public buildings—wherever power, in any of its forms, is needed.

John Paul Taylor

John Paul Taylor
Editor

What is your attitude toward Sales Engineers?

JUSTUS T. VOLLBRECHT,
President, Energy Control Co., Inc.

About Justus T. Vollbrecht

Judd Vollbrecht is one of this nation's leading manufacturer's representatives. He gained his early experience as a sales engineer in Chicago with the J. W. Murphy Co. and then moved to St. Louis where he founded the Economy Equipment Co., a manufacturer's representatives' organization. After many years of success, Judd set up in New York City where he founded the Energy Control Co., Inc., manufacturer's representative organization he now heads as president. Subsequently, he has also founded and heads the Energy Control Co. in Philadelphia.

During his entire career he has demonstrated his ability in improving the important service in our nation's distribution system that is provided by the manufacturer's representative. He is a charter member, and past president of Industrial Marketing Associates Inc., a nonprofit association that aims to upgrade the service that manufacturers' representatives render to the user of industrial equipment.

Another of his major activities has been the Instrument Society of America. He served first as treasurer, and is just now ending his term of office as the president. Judd is also a member of the American Society of Engineers and of the Engineer's Club of New York.

Another recent forward step he has taken was the organization of a school of instrumentation fundamentals, sponsored by Energy Control Co. Inc. and by Industrial Marketing Associates Inc. The school was held at Albany, N. Y.

Judd and his wife Cecilia live with their four children in Princeton, N. J. When not occupied with business and extra curricular duties, Judd relaxes playing golf and bridge.

THE TERM "SALES" too often has been given a negative meaning, implying coercion or the forcing on a buyer of an unwanted or unneeded product or service. Because of this, an instinctive negative attitude is often developed when a salesman calls.

Is this negative attitude justified? Let's think it over. A good sales engineer should be an expert on the products of the manufacturer he represents, and on how these products can best be applied to solve the buyer's problems or to fulfill his needs.

Most companies are doing a splendid job of selecting and educating their sales people. They have tried to overcome this instinctive resistance by calling their sales personnel "application engineers," "factory representatives," or similar titles.

Because enormous sums have been spent on research and development during the past ten years, many new methods, products, and processes have been put on the market. A continuous educational program is conducted by manufacturers to keep the sales engineer properly informed about these new developments. *Informed* buyers always have the welcome sign out for the *informed* sales engineer, since possibly he may have the answer to some of their difficult problems. It is possible that some of these developments will apply to *your* plant.

sales engineers are friendly souls

Remember, the sales engineer is human! He responds to friendliness. As a buyer, you can get much free consulting advice if you will only bring your problems out in the open and explain them fully to your "friend." As a rule, when all the facts are available, a solution is readily apparent. If not, the sales engineer can call upon the extensive research and development experience of his factory engineering department. Quite often, if you have "sold yourself" to him, he will enthusiastically recommend to his principals that they make special adaptations to solve your particular problems. If your problem is affected by peculiar conditions due to location, shape, size, or atmospheric conditions, let him check the plant conditions personally – sometimes he has a "feel for a problem" when he is in the physical center of it.

Remember, he is *your* representative when he is talking to his factory engineers! The better you inform him, the better he can present your story and get action.

The sales engineer is continually encountering problems, not only in your type of plant, but in large and small plants in many different industries. He is constantly getting ideas, not only on his own equipment but on operating problems in general. He is a "gold mine" of knowledge that can be made available to you with a little cultivation. This "cross fertilization" of ideas between industries by sales engineers is one of the reasons behind our rapid industrial expansion.

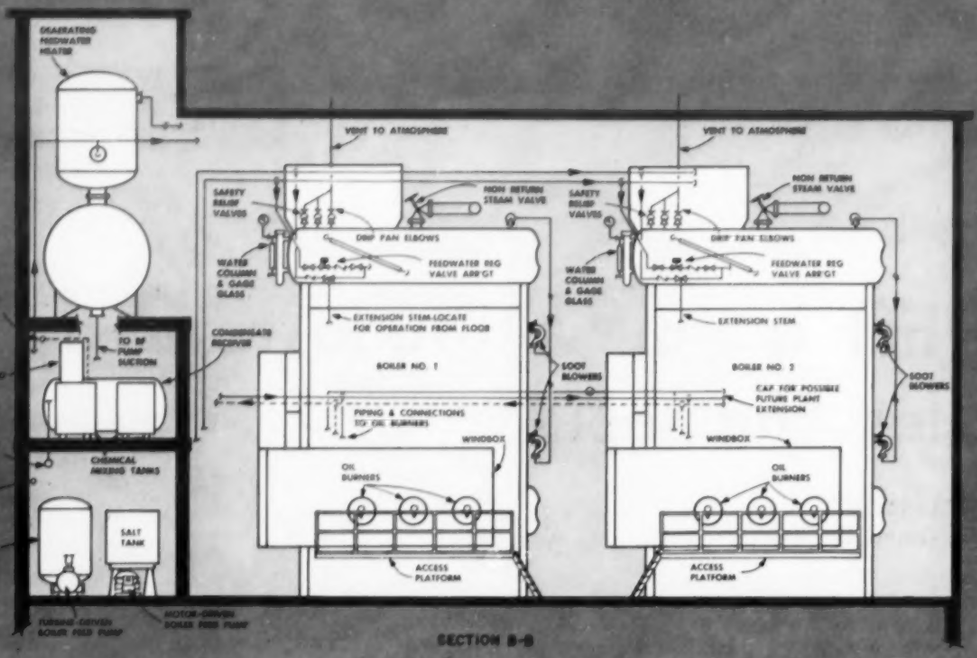
The rapid changes throughout industry being made possible by automatic control has emphasized the necessity of selecting all operating equipment, not only for proper size and capacity, but also for proper characteristics and controllability. As an illustration, if you are purchasing equipment in which combustion takes place, you should be sure that proper provision is made to measure and control accurately both fuel and air. Otherwise, very good primary equipment and very good control equipment, improperly selected, will give only mediocre results. Allow each sales engineer to check his own specialty to be sure your needs are properly met! Information such as this is not in handbooks, or if it is, it must be coordinated to apply to your plant.

why call him an application engineer?

The term "application engineer" is very descriptive of one at the most important functions of the sales engineer. Proper application and good installation are as important as quality equipment.

Sales engineers take pride in their products and want to see that the results obtained are equal to expectations. Poor results often occur because your operators are not properly informed. In a few cases, they may be incompetent. In the first case, the sales engineer can help in training your operators. In the second case, he may be able to recommend someone to do a better job for you.

(continues on page 17)



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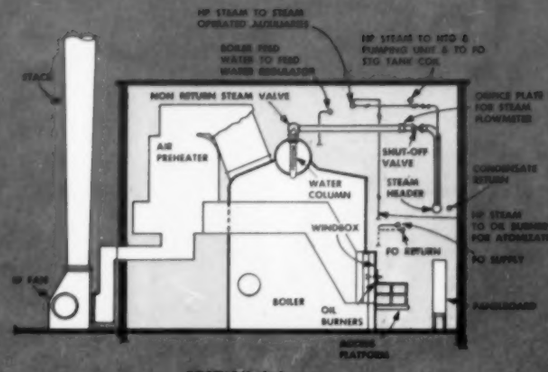

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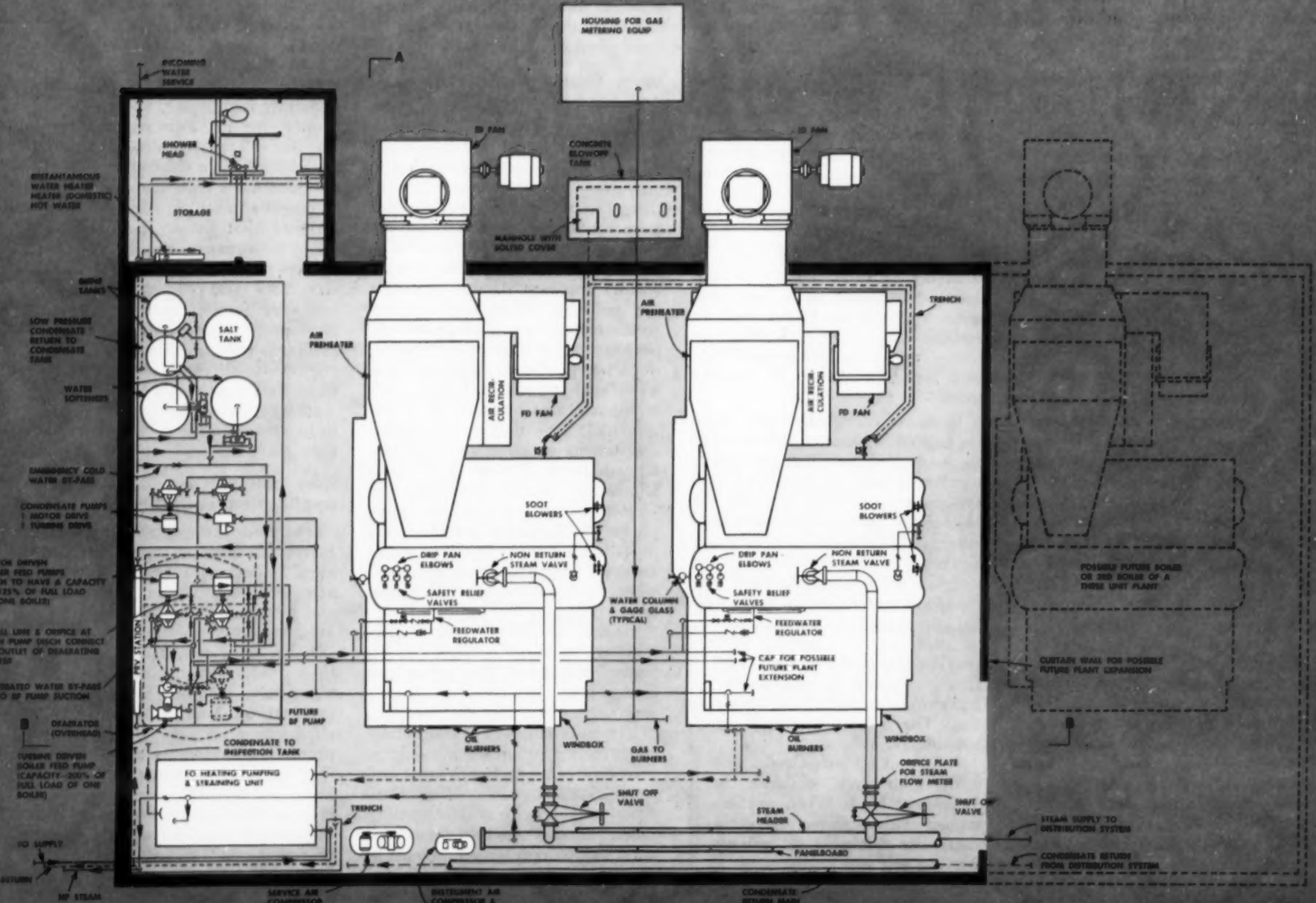


FLOOR PLAN

You can save time and money,
if you need a boiler plant with 100,000 to 450,000 lb/hr capacity,
by using U.S. Navy, Bureau of Yards and Docks

Basic steam plant design

JOHN W. BISHOP
Mechanical Engineer
Power Generating Section
U. S. Navy Department, Bureau of Yards and Docks

THREE LARGEST standard boiler plant designs of the Navy's Bureau of Yards and Docks are for individual boilers with capacities to 150,000 lb/hr. Two of these designs are for boilers ranging from 50,000 to 70,000 lb/hr each, one for oil and/or gas firing only, the other for coal firing with auxiliary oil or gas as required. The first two plant designs have capacities that vary from 100,000 to 140,000 lb/hr in two-boiler plant and up to 210,000 lb/hr in a three-boiler plant. The third design is for a coal-fired plant with auxiliary oil or gas, as required, using 80,000 to 150,000 lb/hr boilers with plant capacities up to 300,000 lb/hr in a two-boiler plant and 450,000 lb/hr in a three-boiler plant.

The first two plants are shown as totally enclosed, whereas the third plant is shown as a semi-outdoor arrangement. The question of whether a totally enclosed or semi-outdoor plant is indicated, is a matter of climate and economics.

oil- and gas-fired boiler plants 100,000 to 210,000 lb/hr

This plant uses boilers of more or less standard design that preclude the engineering cost connected with larger tailor-made types. Entire plant is constructed at ground level and requires no basement.

Arrangement shown in Fig. 1 employs tubular air preheaters for heat recovery. Regenerative air preheaters or economizers may be used, however, instead of tubular air preheaters where economically favorable. Mechanically atomizing oil burners are recommended unless load swings are of such magnitude as to override the additional cost of using steam atomizing burners. Ring-type burners are used for gas firing.

Fig. 1—Basic oil- and gas-fired plant has capacity from 100,000 to 210,000 lb/hr (for 3-boiler plant).

Boilers are two- or three-drum water-cooled furnace type. Heat release in the furnace is limited to 50,000 Btu/cu ft and average heat absorption through the tubes is limited to 9200 Btu/sq ft of heating surface.

coal- (aux. oil- or gas-fired) plants, field-erected boilers

As in the case of the oil and gas counterpart, this plant is also designed for standard field-erected boilers to eliminate special engineering or development work.

This plants' layout (Fig. 2) is also at ground level, and is designed for one man operation, as are all the plants outlined in this series of standardized designs.

Like all the Navy's standardized water-tube boilers, these boilers are water-cooled furnace type. Furnace heat release is limited to 35,000 Btu/cu ft/hr for continuous duty, or 40,000 Btu/cu ft/hr for boilers that will usually operate under partial load conditions. Heat release is recommended as not exceeding 300,000 Btu/sq ft of grate area for continuous duty, or 600,000 Btu/sq ft for low load factor service.

Each boiler has an elevated silo with sufficient capacity to carry the plant over a weekend, to eliminate overtime coal handling labor. Spiral conveyors should be of the most conservative design, so that coal will only be carried on the bottom third of the conveyor. Coal level in the conveyor should never rise as high as the conveyor shaft. Conveyor screw housing should be of split construction to facilitate maintenance. Conveyor screw should be case hardened. It is recommended that all coal hoppers and chutes be ASTM 304 or 316 stainless steel clad (15 or 20%). Silos are provided with a single bucket elevator, serving both (or all three) silos with another chute extending over to the storage pile. A track or road hopper is provided for coal unloading. Reclamation from the storage pile is by bulldozer (also used for storing and compacting coal on the pile).

Ashes are reinjected from all hoppers, except from the dust collector. Ashes from the ash pit and collector are removed by a steam eductor system and deposited in the elevated ash silo.

For bituminous coals, recommended stokers are vibrating- or oscillating-grate, forward ash discharge spreader type or the newly developed chain-grate type that uses high-velocity air jets to promote turbulence at the point of coal feed. Wide-range mechanical or steam atomizing burners (or gas ring burners) are provided on the boiler sides to permit alternate oil or gas firing without disturbing the boiler front.

Heat trap for this plant is also shown as a tubular air preheater, but a regenerative preheater or economizer may be used where conditions so dictate. An economizer is usually more economic where extended light load periods are anticipated, particularly with a high-sulfur coal. Where tubular air preheaters are used, suitable bypasses or recirculating ducts must be provided for light loads to preclude low stack temperatures when sulfurous fuels are being burned. This is most essential when residual fuel oils, often of high-sulfur content, are to be used. The same applies to high-sulfur content coal.

Dust collector, as shown, is of the high draft-loss tubular type. Selecting the dust collector is always a problem. It depends upon the allowable dust emission, the coal being burned, and the type of stoker equipment. Where dust is not a problem, or where a non-friable type coal with a low percentage of fines is being burned, a low draft-loss dust collector will often suffice. If a chain grate high-velocity air-jet type stoker is used, it is often possible to omit the dust collector. An inclined water-cooled grate type stoker, which tends to minimize this flyash problem, is also available.

coal-, oil-, and gas-fired is largest standard boiler plant

This is the Navy's largest standard boiler plant. Semi-outdoor construction is more economically attractive with this size plant than with the smaller plants mentioned before. This must, of course, be tempered by climatic consideration. If the additional maintenance and operating cost (attributable to operating an outdoor arrangement) is much greater than the total

(continues on page 22)

When plant expansion outgrew switchgear capacity at National Vulcanized Fibre Co's. Yorklyn plant, they found they could . . .

save Space and Time with modern circuit breakers

JOHN L. BAHR
Chief Engineer
National Vulcanized Fibre Co.

PLANT EXPANSION, at National Vulcanized Fibre Company's Yorklyn, Del. plant, created the problem of providing additional power facilities. Existing generating capacity, consisting of three turbo-generators, was not adequate to meet demands and provide standby requirements.

To supplement plant generating capacity, National Vulcanized Fibre Company's management decided to purchase part of the required electric power from a local public utility. Purchased power enters the plant at 13,600 volts, 3-phase, 60 cps through a remote-operated synchronizing oil switch and is transformed to 440 volts on the generating and distribution buses. Inter-

New Cordon circuit breakers, with switchboard fabricated by Bull Dog Electric Products Co., fit into restricted space and were installed in minimum time.

TurLogenerator operation is checked after tie-in with purchased power. Parallel operation assures uninterrupted power supply.

rupting capacity of existing switchboard breaker equipment had to be increased to meet new parallel operating requirements. These combined sources of power made interrupting capacity a critical problem.

To provide the proper facilities, various types of equipment were investigated. Specifications required that equipment selected fit into existing space requirements, provide required interrupting capacity, and be economically advantageous.

Continuous process operations require dependable sources of power with minimum outage. This was considered in deciding to operate in parallel with the power company, as well as in selecting equipment.

Cordon circuit breakers were selected because they incorporated advantages of thermal-magnetic molded-case circuit breaker and Amp-trap current-limiting fuses in a compact design.

Since the greater majority of fault currents are of low magnitude, within the tripping range of the breaker's thermal-magnetic elements, these devices will operate to open the breaker, which can then be reclosed without any replacement of parts. Should a fault of high magnitude occur, the Amp-trap current-limiting fuses clear the circuit in less than a half cycle. This limits the magnitude and duration of the current to a fraction of its possible value.

Plug-in type breakers permit changing breaker ratings, as well as inspection after heavy fault conditions, by simple withdrawal without power shutdown. To provide adequate distribution facilities within the limited space available, a new board was designed. This board is completely bussed, incorporating all the desired features. It fits into the required space without affecting the adjoining generating board. All installation work was done over a single weekend.

Thus, National Vulcanized Fibre Company obtained modern, compact interrupting capacity to 100,000 rms amperes at moderate cost and saved time and money during installation. ♦ ♦

For more information about Cordon breakers, circle 1030 on Reader Service Card, page 50.

TIME SCHEDULE FOR CHANGE

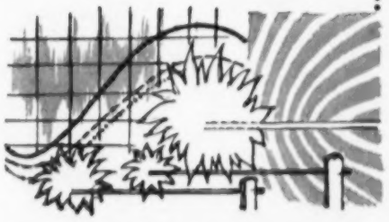
	HOURS
Move new distribution switchboard into Building in 2 sections and locate in convenient place for installation	8
Connect 2 sections of switchboard and mount on common base preparatory to installation. Make preparation for meters and auxiliary equipment	8
Shut off all power and connect temporary feeds from outside source	4
Remove all old distribution boards and breakers	12
Move new board in position and secure	8
Connect all permanent circuits except temporary feeds mentioned above	16
Connect temporary circuits	8
Connect meters and auxiliary equipment	2
TOTAL HOURS	66

CRACKING Problems with 316 and 347 Stainless?

CHAMPION'S

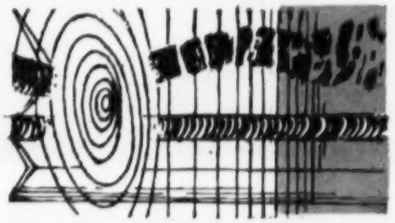
16-8-2 Electrodes Offer freedom from CRACKING

HERE'S WHY: New CHAMPION 16-8-2 Stainless Electrodes have a composition which has much higher hot ductility than any other grade of stainless. Produces freedom from cracking in weld, zone of fusion, or parent metal.



HERE'S WHY: Tests reveal that this composition is not subject to embrittlement on aging, and possesses very good stress-to-rupture properties.

HERE'S WHY: Lime type coating deposits extremely clean, sound weld metal. Handles well in all positions. Low spatter. Easy slag removal. Smooth, even and finely rippled weld bead.



Excellent mechanical properties are accomplished with CHAMPION 16-8-2 Welding Electrodes:

Yield .....61,000 psi
Tensile .....92,000 psi
Elongation in 2" 50%
Reduction of area 61.8%

The chemistry is closely controlled to produce less than 4% ferrite in the deposit.

Typical chemical analysis is as follows:

Carbon .08	Chromium 16.19
Manganese 2.24	Nickel 8.00
Silicon .37	Molybdenum 1.79

Other stainless requirements: CHAMPION offers a complete line of stainless electrodes in a full diameter range from 5/64" to 1/4", lime or AC-DC coated.

FOR FULL DETAILS on CHAMPION'S 16-8-2 or other stainless electrodes write to:

The **CHAMPION** Rivet Co.

Cleveland 5, Ohio • East Chicago, Indiana

Circle 813 on Reader Service card for more data

Analyzer cuts engine maintenance costs

A COMPLETE cost-cutting look at the inner mechanical functioning of complex industrial engines — without expensive shutdowns — can now be made with a new industrial engine analyzer.

The hand-portable, multi-purpose equipment displays pictorially the information formerly obtained from as many as three electronic instruments. Operators and maintenance men can monitor reciprocating engines, either spark-fired or diesel, and keep them operating at continuous peak efficiency. Analyzer also detects and pinpoints malfunctions as they develop.

New 36-lb industrial analyzer is a development of Sperry Gyroscope Co. engineers. It accurately monitors engine operation, providing three types of data: ignition, vibration, and pressure.

Device can be expected to find widespread application in the power, natural gas, chemical, and other industries where large reciprocating engines are used.

Using a highly specialized oscilloscope, analyzer probes the inner recesses of engine and presents functional information in picture form on a 5-in. cathode ray screen. Electronic data are transmitted from engine connections through wires to the control unit where it is converted into pictorial information. Instrument is attached and operated while engine is running. Sperry engineers point out that this feature eliminates time- and money-consuming shutdowns for maintenance checks.

Sensitive to a point where it can detect within one degree of crankshaft position any ignition mistiming, analyzer operates like this: A sweep is driven across the cathode ray tube in time with the engine. Resulting trace line shown across the screen is responsive in the vertical direction to signals from ignition, cylinder vibration, and cylinder pressure. Manipulation of the controls presents a complete picture of engine's operation.

Four connections are required. These are made to the flywheel, ignition primary circuit, and two to a power cylinder. Analyzer is timed to engine by making a fifth pickup located near a mark on the flywheel. All connections may be made without stopping the engine.

And, early tests of a prototype analyzer, which used only two (ignition and vibration) of the three types of data now available, showed the ability to save nearly $4800 monthly for an industrial plant using 80 natural gas engines. ♦ ♦

For more information about Engine Analyzers circle 1038 on Reader Service Card, pages 50, 51.

Epoxy compound eases maintenance problems

Problem: Continuous maintenance problems in lines and pumps plague plant operators who use salt water for cooling or process.

In many installations, cement-lined steel pipe, ranging from 2- to 36-in. dia, is used to handle salt water at pressures up to 150 psi. Any fault or failure of the lining, especially at joints, branch connections, or fittings, may cause undue turbulence and expose metal to rapid corrosion by salt water.

A corrosion problem also exists in casings of large pumps used to circulate salt water from its source to condensers and similar equipment. These gray-iron pump casings are subject to severe graphitization of the entire area exposed to salt water and often exhibit deeply pitted areas.

Construction of new piping, modification of existing piping, and repair of leaks all entail protection of exposed steel at the joint. The problem lies in getting cement to adhere to the metal, especially when it must be applied in thin or narrow sections.

Solution: The Perth Amboy Refinery of The California Oil Company, in conjunction with the Smooth-On Company, developed an epoxy resin and selica compound with excellent adhesion to clean metal surfaces. Compound is immune to salt water corrosion, is non-toxic, has a relatively short setup time, does not crack or spall, and is easy to mix and apply.

Compound is furnished as a two-component system, epoxy compound and accelerator. By using different accelerating agents the setup time can be varied to suit the particular job. Compound can be furnished in a variety of colors as an aid to future inspection. It has the consistency of a heavy putty, can be trowelled on easily, and stays in place even with severe handling. The Perth Amboy Refinery has successfully used this material to fill deep pits and eroded areas on one of the main 40,000-gpm salt water pumps.

Epoxy resins, compounded with various accelerators and fillers and using glass cloth for reinforcement, are finding an increased application as maintenance tools to stop leaks and resist corrosion. ♦ ♦

For more information about epoxy compounds, circle 1039 on Reader Service Card, pages 50, 51.

Sales engineers

. . . starts on page 11

The manufacturer's sales, design, and production engineers, are always anxious to be sure their products are satisfactory. No matter how good the design, no matter how careful the inspection, the only real test of a product is – how does it stand up in service in the customer's plant? The sales engineer, with your cooperation, can take back to his factory engineers the complete story on any problems you may be having and can help to correct the design.

he calls to help you with your problems

To sum up, the sales engineer is calling on you to help you solve *your* problems. He has gone through extensive training in his special field. He should be considered a "special consultant," whose services are a plus value when you purchase his equipment.

how to get a bargain

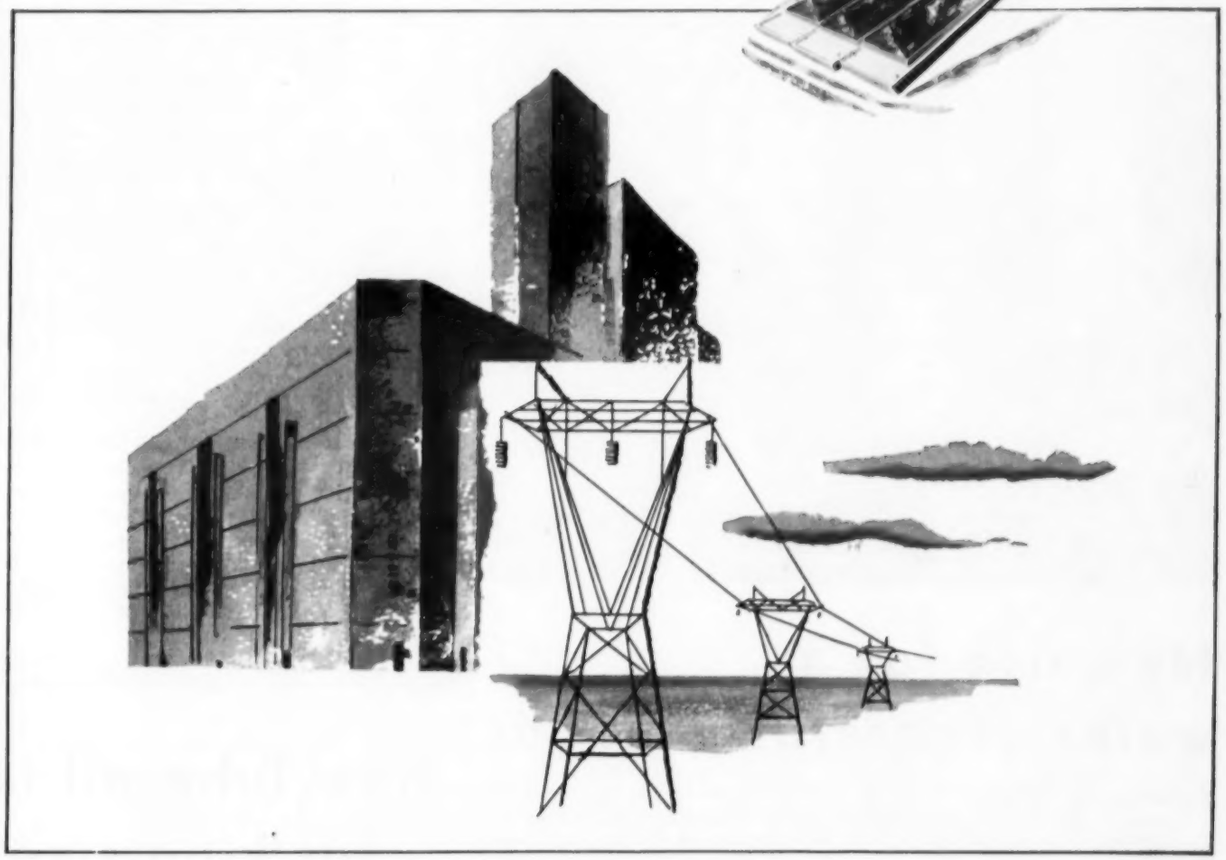
You can get your best "bargains" from him only if you

- Give him a friendly welcome
- Treat him with respect
- Explain your problems in detail
- Consider him *your* representative in his dealings with his factories
- Let him keep you abreast of developments within his field.

Make the informed sales engineer your friend and he will help you to make your position more interesting and more secure. ♦ ♦

I'm going to give you a board away from the door so you won't get hurt at 5 o'clock.

PUBLIC UTILITIES



. . . one of the basic industries supplied by UNITED ELECTRIC with coal shipped by the All-Water Route on the Inland Waterways and to Great Lakes Ports

United Electric pioneered the all-water route which now makes huge tonnages of coal available by low-cost transportation to public utilities and industries on the Inland Waterways and at Great Lakes Ports. This new economical coal distribution service offers you important benefits. The United Electric Representative will be glad to give you full information.

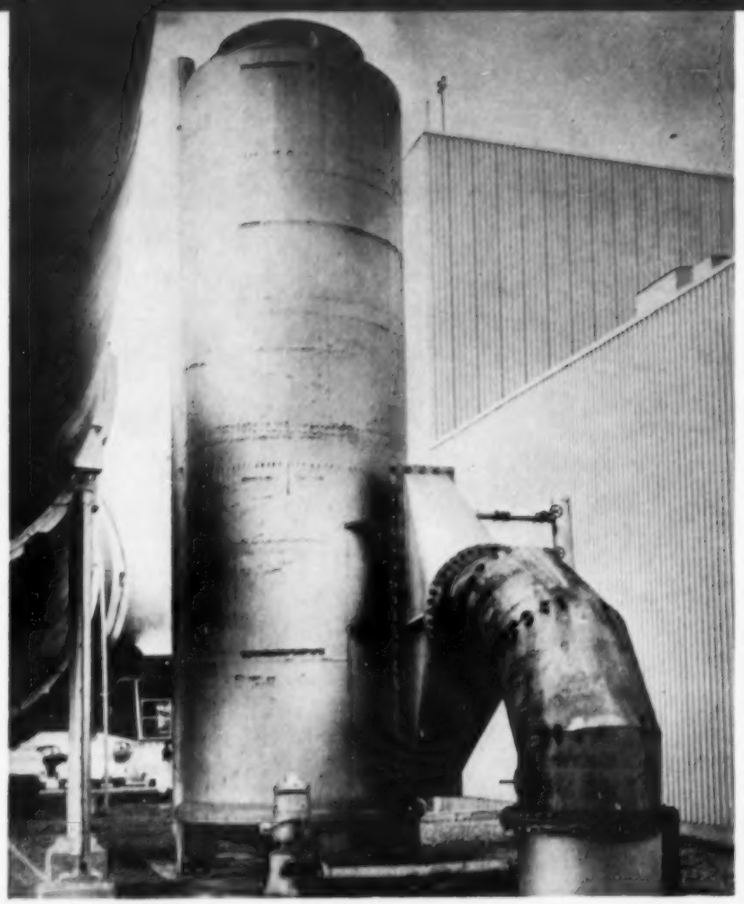
BUFFALO CREEK	FIDELITY	CUBA-BUCKHEART	MARY MOORE	RUBY
washed West Kentucky No. 6 industrial and domestic stoker coal	*domestic and industrial stoker coal*	*precision prepared coals*	*No. 7 Illinois for industrial and utility use*	*washed West Kentucky No. 11 for industrial and domestic use*

ruby

THE UNITED ELECTRIC COAL COMPANIES

CHICAGO, 307 N. Michigan Ave., Phone CEntral 6-6580 • PEORIA, Commercial National Bank Building, Phone 3-3711 • ST. LOUIS, Ambassador Building, Phone GArfield 1-3732

Circle 808 on Reader Service card for more data



New use for a water separator snubber

Problem: The National Advisory Committee for Aeronautics Lewis Flight Propulsion Laboratory at Cleveland, Ohio, was concerned with silencing the discharge from two 40-in. bore by 14-in. stroke, eight-cylinder compressors. Machines are used to exhaust air from a closed chamber to atmosphere. Oil from the discharge of other vacuum pumps had proved to be quite a nuisance in the area.

Initial plans to overcome this situation called for an exhauster head on top of the silencer. Water would be sprayed into the exhauster head, in an attempt to remove entrained oil from the air stream.

Solution: After an engineering study, NACA purchased a Burgess-Manning water separator snubber, eliminating the need and cost of the exhauster head. This equipment was originally designed to provide the dual function of exhaust gas silencing and removing seal water from the exhaust gas of vacuum sealed pumps. The B-M water separator snubber measures 9 feet dia and 35 feet tall. It handles up to 100,000 cfm of air and separates up to 1200 gpm of water from the exhaust stream. Water, introduced in the inlet nozzle of the separator, washes all oil out of the air stream. Water separation and consequent oil separation are close to 100% effective under normal operating conditions. Oil and water drop into a sump below. Oil is separated by an overflow arrangement, leaving the water in condition for recirculating.

product service is varied

The limit of a product's service horizon is never really known—new applications develop when least expected. So it is with the B-M water separator snubber.

This unique combination of separation and silencing, plus oil removal, represents a noteworthy saving in equipment cost. It guarantees continuous, uninterrupted performance with essentially no maintenance. ♦ ♦

For more information about WSS Snubbers circle 1033 on Reader Service Card, pages 50, 51.

Vinyl coatings are longer lasting

A VINYL COATING SYSTEM for chemical storage tanks is lasting more than three times as long as conventional corrosion-resistant coatings under similar severe atmospheric conditions. Davison Chemical Company, Division of W. R. Grace & Co., painted six 33,000-gallon ammonium hydroxide storage tanks at its Lake Charles, La., plant with Amercoat No. 33, a coating based on Bakelite vinyl resins to give utmost protection. This coating, formulated by Amercoat Corporation, South Gate, Calif., has given successful service on these tanks for more than three years. Two coating systems previously used failed in a year or less. Coatings based on Bakelite vinyl resins are showing excellent resistance to acids, alkalies, oils, weathering and abrasion. They are also resistant to cracking and chipping. The inherent flexibility of the coatings allows for expansion and contraction of the metal tanks with temperature changes.

The tanks, 10½ feet dia and 53 feet long, were first sandblasted for proper surface preparation. A white top coat was used to reflect the sun's rays and to minimize vaporization of ammonia in the tanks.

First coat was applied by brush and three additional spray coats were applied giving a total film thickness of .006 to .008 in. Extra coats were applied to welds, corners and rough areas to insure thorough coverage.

Since vinyl-base coatings require a relatively short application time, down time for equipment is held to a minimum, and additional savings are possible because coatings require little or no maintenance. ♦ ♦

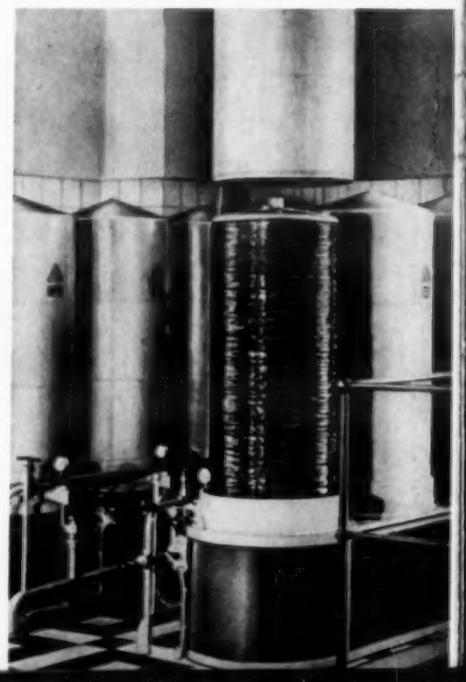
For more information about Vinyl coatings circle 1034 on Reader Service Card, pages 50 and 51.

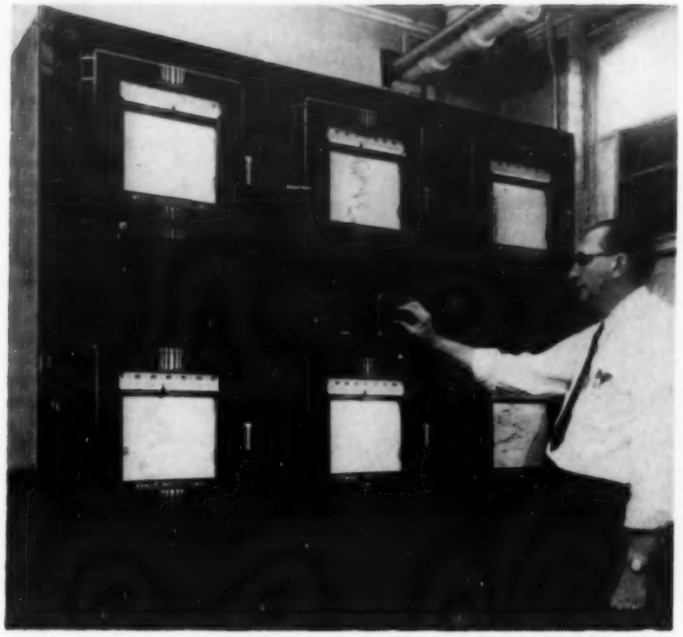
How lube oil is filtered for king-size diesel

A BATTERY OF SIX filters in Denmark's largest power station at Copenhagen is extensively reducing oil, labor, and filter costs.

Copenhagen's Orsted station uses a 22,500-hp Burmeister & Wain crosshead diesel engine rotating at 115 rpm, normally circulating 45 tons of lubricating oil. CJC Fine-Filters, manufactured by Norse Electric Manufacturing Co., were cleaned for the first time 3 months after installation. During the cleaning, more than 700 lbs of concentrated filter sludge were removed. Despite the filters' tremendous removal capacity, strainers need to be cleaned less often than before. ♦ ♦

For more information about CJC Fine-filters circle 1035 on Reader Service Card, pages 50 and 51.





Load measurements at Allegheny Ludlum's works at Brackenridge and West Leechburg are transmitted to this centralized control panel that provides automatic load control and continuous load recordings.

Automatic load control saves $30,000 monthly

A saving of $4750 in demand charges during first month's operation of a new automatic load control system is reported by Allegheny Ludlum Steel Corp. During the month, Allegheny consumed 400,000 kwh more energy, yet their net bill was $3150 less than the previous month – the 400,000 kwh being an extra "no charge" bonus. Currently the company estimates savings at 20,000 kw (about $30,000) per month.

For electric melting furnaces, Allegheny bought electric power that peaked to well over 100 mw, if unregulated. Total power bill consisted of a 15-minute demand charge (about $1.80 per kva per month) and an energy charge of about $0.004 per kwh. Analysis of their load control curve by field engineers showed that substantial savings would result if demand were reduced, and that this could be done without reducing production.

A Leeds & Northrup load control system was installed to regulate the 15-minute demand, rather than the instantaneous kw, as in a normal control application. This control integrates the kw hours excess over the desired demand period and then automatically determines the required load reduction. If load trend indicates that the schedule will be exceeded, the regulator resets controls on electric furnaces, reducing their load. The control automatically selects furnace or furnaces which are melting (creating excess demand) without disturbing the furnace under refining operation (contributing only slightly to excess demand).

Control now regulates demand at about 70,000 kw. On a monthly average, peak demands fall within 1500 kw of this desired value. In one month, the five peak demands were within 1000 kw of each other resulting in a real saving in demand charges plus maximum consumption of kw hours. Engineers estimate that at this rate the equipment will have paid for itself well within six months. ♦ ♦

For more information about load control, circle 1032 on Reader Service Card, pages 50 and 51.

RAMBLINGS ON INSTRUMENTATION

Surprise Package

A friend of ours recently was griping about some troubles he was having with the controls in his steam plant. He had a packaged boiler which had been furnished complete with burner, the burner having been furnished with Brand B type control (to coin a phrase, "in one big ball of wax").

All was peachy until it turned out that the control wasn't doing the required job. When the boiler people were contacted, our friend was told to check with the burner people who sent him to the control manufacturers who said, "Sorry, no service available."

When he asked us for a comment, we told him that we liked to suggest that the burner be left to the burner manufacturer and the boiler to the boiler manufacturer.

But when it comes to controls, we feel that these should be left to control manufacturers (people like us) who not only engineer the specific job better, but can also service it if it is required. Buying your controls this way pinpoints responsibility, assures a fully engineered job and prevents the customer from having to become a "do-it-yourself" engineer.

Guide Right!

For four months we've taken you on a Ramblings Safari into the intricacies of boiler plant control systems. As threatened in our last installment, this month we'd like to talk about combustion guides.

If you've been paying attention, you know by now that a combustion control system is designed to maintain the highest combustion efficiency possible. The combustion guide serves as a check on the efficiency of the system.

These combustion guides are pretty useful gadgets. Specifically they:

1. aid in control calibration
2. give visual evidence of combustion efficiency
3. give you a historic record of combustion conditions
4. aid in fuel switch over

Finally, if you pick an electronic gas analyzer as your guide, it serves as a dandy lunch warmer.

There are four different instruments which will do the job and Hays makes them all. These are:

1. The boiler efficiency meter, a recorder where the air flow and steam flow pens are kept together by changing the fuel-air ratio of the control system. This is a *quantitative* measurement where actual fuel and air are metered.
2. The combustion meter, an automatic orsat analyzing the combustion gases *qualitatively* as an indication of fuel-air ratio. This low-priced, fully automatic, mechanically operated instrument provides a record of CO_2 in combustion gases.

Ain't science wonderful! This O_2 meter proves everything's Jim Dandy!

3. The Condu-Therm CO_2 Analyzer, a fully electronic thermal conductivity type analyzer having no analyzer moving parts, requiring no chemicals. It provides a continuous record of CO_2 in the flue gas.
4. Magno-Therm O_2 Analyzer, a magnetic type unit which analyzes flue gas for O_2 as a function of excess air. It is not affected by variations in fuel composition, % of O_2 remaining constant at the same excess air, despite variations in fuel.

We'll cover these a little more thoroughly in the next few installments. If you can't wait for more details, however, just send us your name and we'll mail you an 8-page booklet in two beautiful colors, slyly canted toward Hays equipment.

See you next month.

Phil Sprague Jr.
President

THE HAYS CORPORATION • MICHIGAN CITY, INDIANA

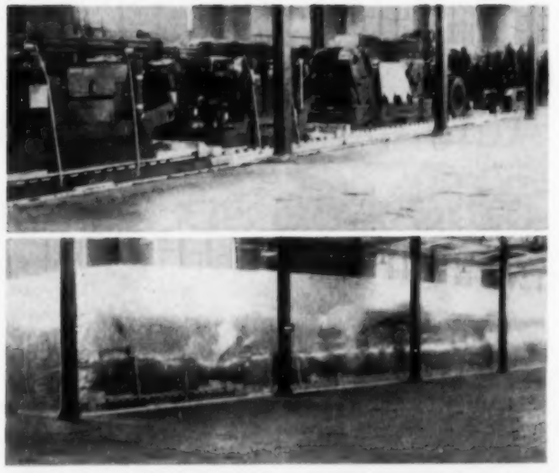
Circle 842 on Reader Service card for more data

PI Photo News

NEW ONSHORE take-away system under construction at Salem Harbor Station, New England Power Co., will allow super colliers to operate at maximum discharge rate. Belt is enclosed in 10-ft dia pipe (above) equipped with gates permitting coal to flow by gravity from open storage.

PROGRAM to protect specifiers and users from incorrect or improper performance ratings of air moving equipment is outlined by Air Moving and Conditioning Association. Program will provide means of identifying products properly tested and accurately rated according to AMCA Standard Test Code. Examining AMCA symbol are, left to right, Marshall F. Allen, Detroit, new executive vice president AMCA; L. O. Monroe, retiring executive vice president, AMCA, Detroit; E. E. Trickler, chairman, AMCA Certified Ratings Committee, and vice president, New York Blower Co., Chicago; and W. H. Rietz, AMCA president, and president, ILG Electric Ventilating Co., Chicago.

WALTER A. SCHMIDT, President, Western Precipitation Corp. is named recipient of Air Pollution Control Association's Frank A. Chambers Award. Mr. Schmidt, right, receives congratulations from St. Louis Mayor Raymond R. Tucker and C. W. Gruber, chairman ACPA Awards Committee.



EQUIPMENT FROM a complete shell packing line at Ohio's Ravenna Arsenal (top photo) is stored in giant plastic bag. Polyethylene hutment (bottom photo) preserves equipment on standby basis, gives perfect pressure and humidity control.

ELIMINATING HOURS of slide rule and hand calculation, this desk-top analog computer solves day-to-day power transmission problems. Handles problems that are too large to do by hand calculation, too small for large computers. Computer is product of General Electric Company.

THIS GATE NEST of heavy tonnage piping constitutes Dravo-built major marshalling yard for routing 83 billion cubic feet of gas annually through lines of Manufacturers Light and Heat Co.'s Majorsville, W. Va., compressor station.

POWER BASICS FOR TODAY'S INDUSTRY

Fluid mechanics – IV

Viscosity: its effect on fluid flow

By now, we have all been given the annual brain-washing about getting ready for winter, particularly in regard to the family car. Every sensible engineer remembers to change the oil because he knows summer-weight oil becomes too viscous as the mercury drops. But how else does viscosity affect fluid flow? — read on and brush up on this vital subject.

PROFESSOR JAMES M. ROBERTSON
Theoretical and Applied Mechanics
University of Illinois

VISCOSITY, of all the properties of fluid bodies, has most effect on nature of flow. A viscosity change, resulting, say, from a comparatively small temperature change, may have considerable effect on velocity of a falling body or head loss due to flow of fluid through a conduit. It is possible for these quantities to change by a factor of two with only a small change in viscosity.

viscosity of fluids

As previously stated, viscosity is a measure of resistance to shearing motion of a fluid body. It is a coefficient which relates unit shearing force τ to lateral velocity gradient in the relationship

$$\tau = \mu \frac{du}{dy} \qquad (1)$$

Units of viscosity μ are lb-sec/ft². In certain cases, it is possible to use eq. 1 directly for the solution of problems.

EXAMPLE: A 3-in. dia piston, 6 inches long, moves along a cylinder. The diametral clearance is 0.006 inches and the annular space is filled with an oil of viscosity $\mu = 0.004$ lb-sec/ft². What force is required to move the piston at a speed of 40 feet per minute?

SOLUTION: Since the clearance is quite small compared with piston and cylinder diameter, we assume velocity varies linearly, whence

$$\frac{du}{dy} = \frac{40/60}{0.003/12} = 2667 \text{ ft/sec per ft.}$$

The shearing stress from eq. 1 is

$\tau = 0.004 \times 2667 = 10.67$ lbs/ft²

Surface area of the cylinder, upon which this stress acts, is

$A = \pi DL = \pi\ 3 \times 6 = 56.6$ in²
or 0.393 ft².

The force is thus

$F = \tau A = 10.67 \times 0.393 = 4.2$ lbs

If we had used cylinder diameter instead of piston diameter to calculate the area, the force would appear to be 0.2% larger. Since, according to a basic principle of mechanics, action and reaction are equal and opposite, we have a discrepancy. This merely indicates the error introduced by our assumption of a linear variation in velocity between piston and cylinder.

In many flow situations, the velocity variation is far from linear. Eq. 1 is still applicable, but we must use other information to evaluate how shear τ varies with position in the flow as indicated by the distance y from the wall. Once this expression is found, the necessary relationships for obtaining solutions to our problems are obtained with calculus.

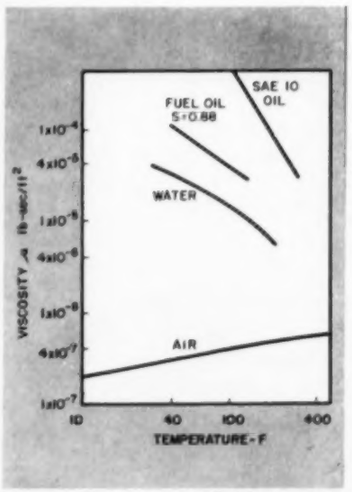


Fig. 1—Variation of fluid viscosity with temperature. Viscosity of gases increases with temperature.

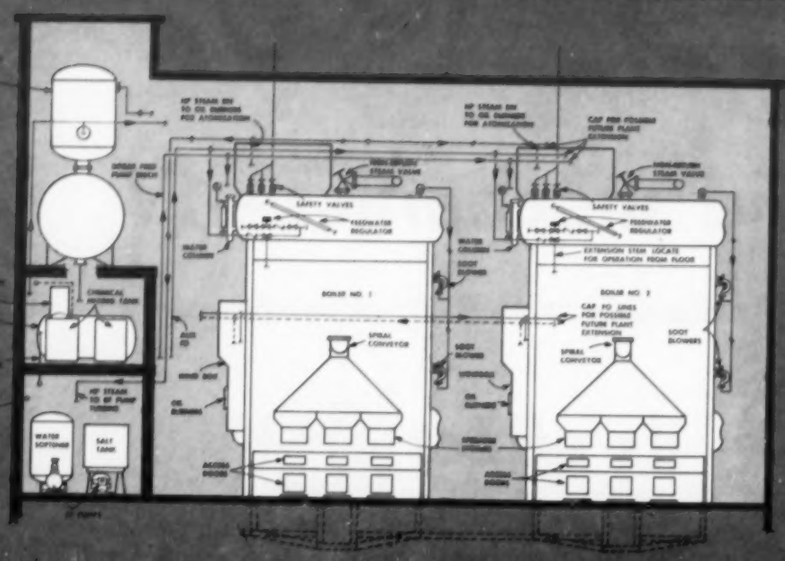
Since viscosity has such an important effect on fluid flows, it is important to realize that it depends not only upon the particular fluid but also upon temperature. Viscosity of gases increases linearly with temperature. Viscosity of liquids decreases with increase in temperature. This variation is indicated in fig. 1 from which we see that the viscosities of gases are significantly less than those of liquids. The effect of pressure on viscosity of fluids is negligible unless extreme pressure changes are encountered. In the case of the kinematic viscosity coefficient $\nu = \mu/\rho$, however, we do have a pressure variation for gases, since their density ρ is greatly affected by pressure. This is not so for liquids and ν is essentially invariant with pressure changes. Kinematic viscosity of air is larger than that of water even at pressures as high as 100 psi.

some anomalous fluids with varying viscosity

Certain substances that we might ordinarily class as fluids do not obey our viscosity law of eq. 1. These substances, such as plastics and inverted plastics, are termed *non-Newtonian fluids* since eq. 1 was initially postulated by Newton. The significant difference from fluids is that for these materials the viscosity μ in eq. 1 is not a constant but is a function of the stress level or possibly the previous history of the material. When prior working or shearing influences the stress-rate of strain relationship, the substance is termed *thixotropic*. Printer's ink and gels are thixotropic. Excepting such substances, we classify fluid-like materials by how the rate of strain varies with shear stress. This variation is depicted by lines on the stress-rate of strain diagram (fig. 2). On this plot, our true or Newtonian fluid gives a straight line passing through the origin. Viscosity μ is thus a constant $\mu = \frac{\tau}{\frac{du}{dy}}$

A plastic material is one that begins to flow only when a certain yield stress is exceeded. Sludges and slurries behave in this way. Value of the yield stress and slope of the line after yield depend upon the particular material. In conduit flow, shear stress varies from a maximum value at the wall to zero at the center. Plastic substances flow in a manner called plug flow. An essentially solid plug of material, for which shear stress is below yield stress, moves down the conduit surrounded (or lubricated, as it were) by material behaving in fluid-like manner due to the

(continues on page 26)



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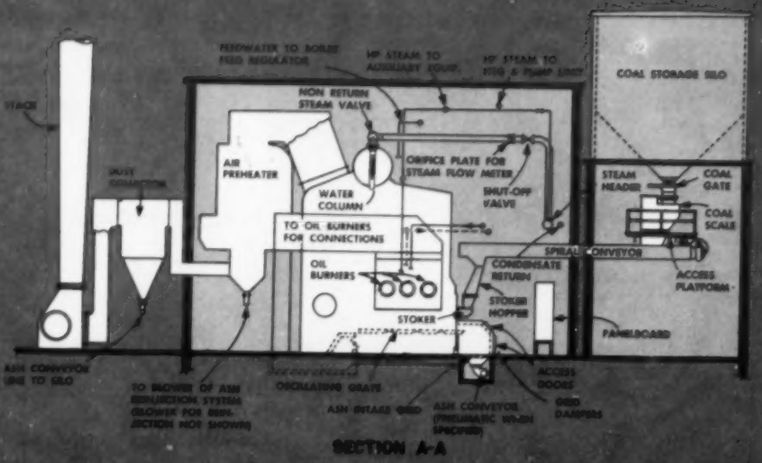

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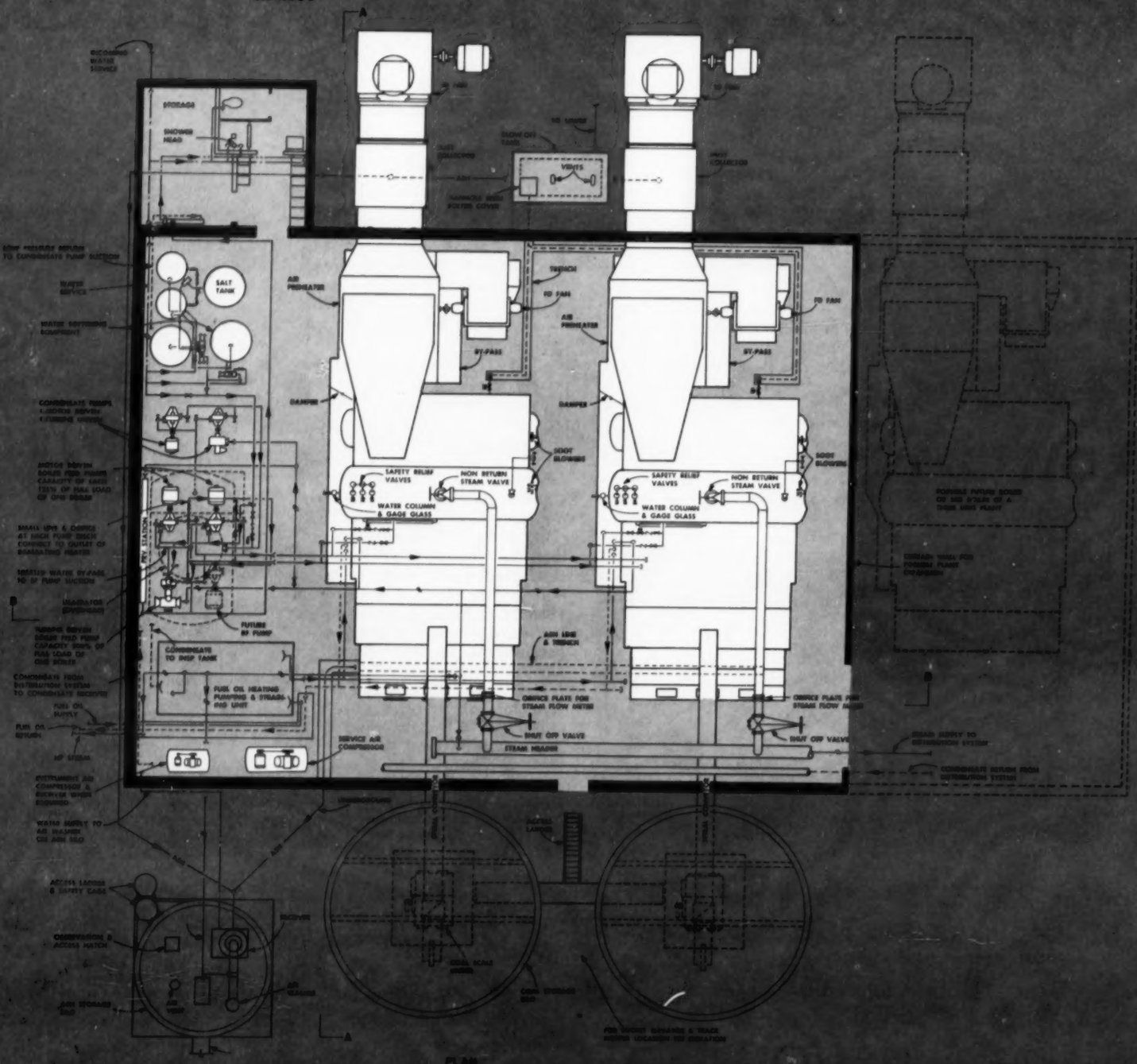


PLAN

Basic steam plant

. . . starts on page 13

annual fixed charges incurred by the additional investment for a totally enclosed plant, then build a completely indoor plant.

Individual silos, coal scales, chutes, and the ash removal and storage system are similar (except in size and capacity) to the 100,000 to 210,000 lb/hr plant. Boiler furnace heat releases are pegged at the same values. The heat trap for this plant is shown as an economizer, although an air preheater may be substituted, particularly if boilers are to be kept at near full load most of the time or if the fuel being burned is low in sulfur content. Selecting the dust collector best suited for the job is again a function of the fuel burned and the allowable flyash emission.

Spreader stokers with traveling grates are used, although a high-velocity overfire-air chain-grate stoker may be substituted.

Because of the outdoor construction, no table of dimensions has been prepared. The plant shown in Fig. 3 utilizes 100,000 lb/hr boilers with plant capacity of 200,000 lb/hr for a two-boiler plant and 300,000 lb/hr for a three-boiler plant.

auxiliaries are generally applicable to all plants

In general, power-driven auxiliaries should be selected, with some steam and some electrically driven to realize maximum heat balance advantages. In other words, there should be enough steam auxiliaries to utilize all available byproduct power in reducing high-pressure steam to deaerating heater pressure. Conversely, there must be sufficient electric auxiliaries to carry the balance of the plant's power requirement, to obviate exhausting steam to atmosphere. This can be done by having some auxiliaries steam driven, some electrically driven, and some dual turbine-motor driven. A good flexible design will permit full use of steam auxiliaries during heavy loads and use of electric auxiliaries during light loads.

Residual oil storage is recommended to be above ground (wherever possible), surrounded by a dike. Dike should be large enough to retain the capacity of the largest tank, plus 10% of the capacity of all the others, with one foot of freeboard. Suction and bunkering pipes must be as near to tank buttoms as possible to prevent building up sludge formations. Tanks should be changed over frequently, and each tank should be bunkered every time oil is received. Emptying one tank, while others remain idle, will usually result in a sludge problem. Suction heaters that heat only at the point of suction are recommended. Heating the entire tank by steam coils or hot return oil is not recommended, since this creates a heat loss from tank radiation. Hot return oil should go to the fuel oil service pump suctions.

Duplex fuel oil pump and heater sets are provided, using rotary gear displacement pumps, large enough so that one pump

(continues on page 25)

TABLE I — MAXIMUM ALLOWABLE OVERALL PLANT DIMENSIONS

Two-boiler Plant Capacity	*Oil- and Gas-fired Boilers (Fig. 1)*			*Coal-fired (aux oil or gas) Boilers (Fig. 2)*		
	Height	*Width*	*Length*	*Height*	*Width*	*Length*
100,000 lb/hr	36 ft	50 ft	63 ft	37 ft	54 ft	66 ft
120,000	36	50	67	37	54	70
140,000	36	50	71	37	54	74
Three-boiler Plant Capacity						
150,000 lb/hr	36 ft	50 ft	84 ft	37 ft	54 ft	87½ ft
180,000	36	50	91	37	54	94
210,000	36	50	98	37	54	100

Fig. 2—Coal-fired (aux. oil or gas) plant is same capacity as fig. 1.

Hospital emergency calls for mobile boiler

WHEN A GAS EXPLOSION cut off all heat from the St. Catherine Hospital, Kenosha, Wis., a call went out for an emergency boiler. A mobile Cleaver-Brooks LRM-20, 200-hp boiler was rushed by police escort and restored steam and hot water within 11 hours.

Natural gas had seeped into the three-story boiler room of the hospital after a power shovel had poked a hole in an underground main. The gas exploded with such force that the top third of a sixty-foot chimney tumbled down. Both an older 125-hp gas-fired HRT unit and a 125-hp coal-fired unit in the boiler room were badly damaged. Gas crews arrived on the scene soon after the blast, which was confined to the boiler building separate from the hospital.

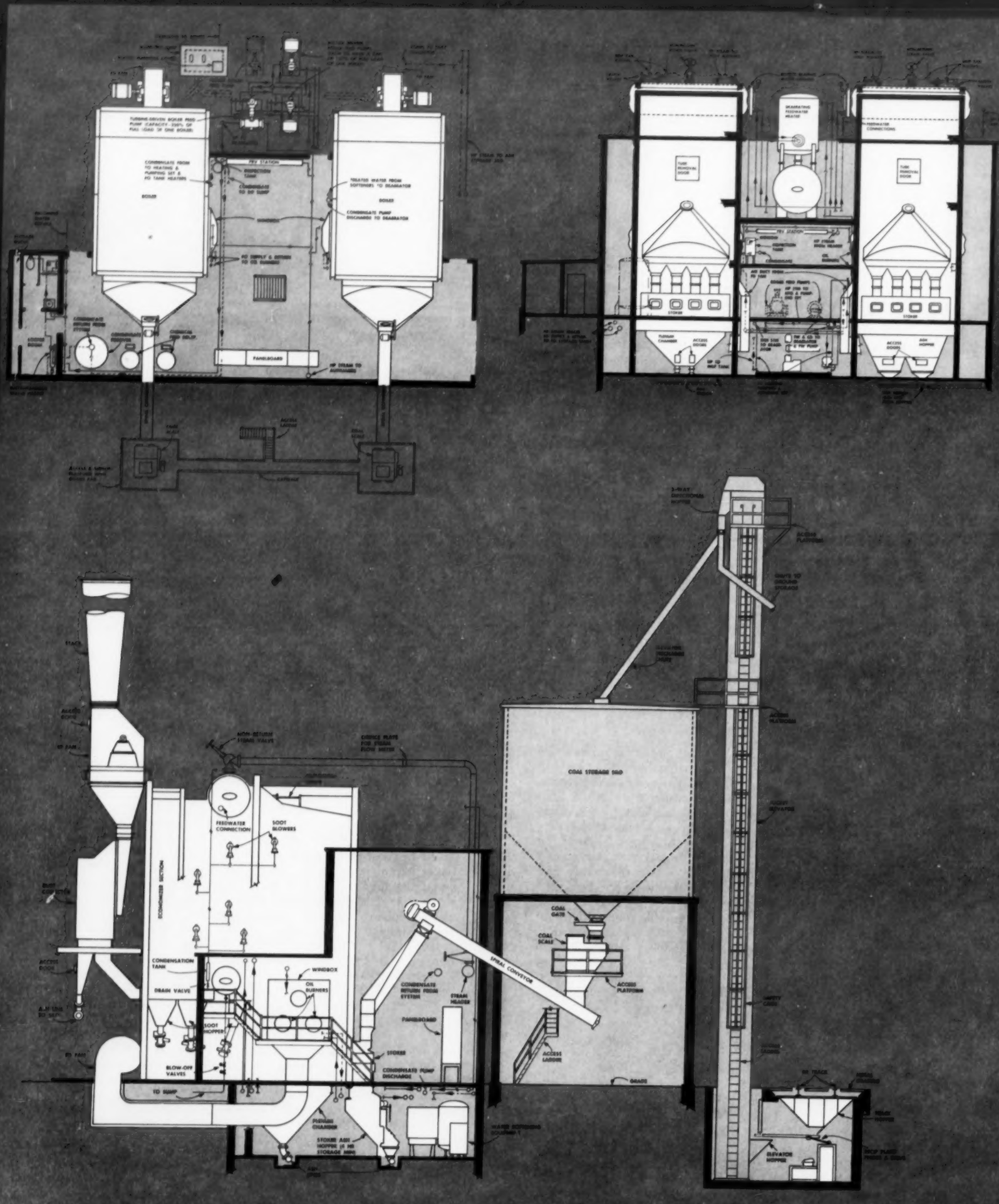
Hospital authorities telephoned the Cleaver-Brooks Company for the portable unit at noon. Service representatives worked until steam was piped into the building.

The 200-hp Cleaver-Brooks mobile unit, which supplied emergency steam, was one of 20 produced for the Army Corps of Engineers in 1949 for use in air bases around the world. The boiler is rated at 200 hp (6900 lb/hr steam), has a design pressure of 150 lbs. The boilers were put through their paces at the Aberdeen, Md., Proving Grounds and were then assigned to overseas duty.

Boiler starts on light oil but is designed for continuous operation on heavy oil. A preheater heats oil to a temperature necessary for proper atomization and the highest practicable combustion efficiency. Boiler is started with a gasoline engine and is then switched over to a diesel. The diesel engine drives secondary air blower, generator, boiler feedwater pump, oil pump, and operating lights on the heavy duty trailer.

Beside putting the boiler out of operation, the blast disrupted telephone service to the hospital for an hour. Fireman pulled down unsafe portions of the chimney. Flying bricks broke windows in a nearby convent and damaged the roof of the boiler building. Hospital authorities did not immediately determine the estimate of damage. The Cleaver-Brooks' emergency boiler will continue to serve the steam needs of the hospital until further notice. ♦ ♦

For more information about mobile boilers, circle 1036 on Reader Service Card, pages 50, 51.


COAL STORAGE SHED
SPIRAL CONVEYOR
ELEVATOR HOPPER
FEEDWATER CONNECTION
SOOT BLOWERS
CONDENSATION TANK
WINDBOX
OIL BURNERS
STOKER
ACCESS PLATFORM
ACCESS LADDER
GRADE

and one heater will handle the normal plant peak load.

Oil burners are wide-range mechanical atomizing or steam atomizing type. Steam atomizing burners are recommended only where load fluctuation and sustained light loads make the steam atomizing burner more economic, notwithstanding the steam required to operate them.

gas systems

Gas-fired installations incorporate a pressure-reducing station, piping, gas ring type burner, with pilot and safety flame-failure cutouts.

coal handling systems

All coal systems described serve the silos with a bucket elevator that can deliver coal to any silo or to the storage pile. Coal is fed to the elevator from a track hopper. Stored coal is distributed and compacted with a bulldozer, also used for reclamation of storage to silos (by pushing the coal into the track hopper).

Coal firing systems embody stoker firing only. Pulverized coal firing is not normally recommended because of higher first cost, power required to operate mills, and more rigid coal specifications required.

fans and controls

Forced- and induced-draft fans are centrifugal load-limiting type, designed for the highest temperature involved. Capacity should be specified for 10% excess volume at 30% overpressure, taking into account draft loss in boiler, air preheaters, economizer, dust collectors, ducts, and breeching.

Combustion controls are full metering type, regulating air flow and fuel flow to provide a constant air-fuel ratio throughout the load range.

Single-element (based on water level alone) feed regulators will suffice for most installations. The two-element type (based on water level and steam flow) should be specified for installations with rapid load fluctuations.

Individual recording boiler flow meters on each boiler are recommended, along with steam pressure, air temperature, and stack temperature recorders. Each export steam line should be provided with a recording flow meter. Plants providing a heating load should have an outside air temperature pen included, as a means of detecting steam wastage on the outside system.

feed water treatment

Deaeration and feedwater is accomplished with a spray- or tray-type deaerating heater, using 2 to 5 psig steam and providing 216 to 222 F water with less than 0.005 cc/l dissolved oxygen. Tray-type heaters are recommended for plants subject to extended periods of light load.

Typical internal treatment consists of feeding disodium phosphate and caustic soda (where necessary) to the boiler drum and sodium sulphite to the deaerator storage tank. Total dissolved solids are controlled by continuous blowdown from the steam drum. Suspended solids are controlled by bottom blowdown. Periodic tests (every 4 to 24 hours) must be made to determine the concentration of boiler chemicals, alkalinity, total dissolved solids, and so on. The necessary testing equipment must be provided in the plant.

External treatment, for average water, will usually consist of a sodium or hydrogen cycle zeolite softener. Individual requirements may vary from no treatment at all to thorough demineralization.

In the final analysis, it is suggested that a competent water consultant be contacted prior to the construction of any plant described in this article.

boiler feed pumps

Feed pumps should have different capacities to provide flexible operation. For instance, a two-boiler plant might well be equipped with one steam-driven feed pump with sufficient capacity for both boilers and two electric-driven pumps (one standby) with one-boiler capacity. This will provide the triple advantage of operating only one pump at a time, keeping the one operating pump at an efficient load, and taking maximum advantage of heat balance. The steam-driven pump will operate and provide byproduct steam during periods of high load. Electric pumps are available for light loads when the deaerator would be incapable of absorbing the steam-driven pump exhaust, resulting in atmospheric exhausting of steam.

None of the designs that have been described in this and previous issues of POWER INDUSTRY are intended as final. All the special features and economic considerations of each individual requirement must be thoroughly evaluated. These outline designs should only be considered as guide lines toward the design of boiler plants which, under average conditions, should provide inexpensive steam with regard to both investment and operation. ♦ ♦

This series of basic boiler plant designs has been intended only as a guide when you are considering your new plant. Obviously, many local factors will influence the final plans. The designs were made with the express purpose of reducing government costs—popular opinion notwithstanding. They are passed on to you in the hope that you might save money, too.

Fig. 3—Coal-, oil-, and gas-fired plant goes to 300,000 lb/hr.

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. . . starts on page 21

higher shear stress near the wall. A fluid carrying other material in it will act as a suspension if the concentration is not large. Suspensions behave in a manner intermediate between plastics and true fluids (fig. 2). Inverted plastics or dilatants are materials for which the rate of strain du/dy decreases as the stress level rises. Quicksand is a classic example of a dilatant.

Methods of analyzing flows of these various substances become rather involved since we no longer have a simple relationship between shear stress and rate of strain. We can profitably leave these substances at this point.

laminar conduit flow can be analyzed directly

Fluid flow in conduits may be either laminar, in which viscosity has a direct effect on the flow details, or turbulent, in which the effect of viscosity is indirect. Although the majority of our problems involve turbulent flow, we shall first consider the laminar-viscous case, since this is amenable to direct analysis.

Our basic concern in conduit flow is the relationship between rate of flow, size and proportions of the conduit, the fluid, and rate of pressure drop or head loss. Although not strictly applicable to laminar-viscous flows (it is really for turbulent flows), the following expression is commonly utilized:

$$\frac{\Delta p}{\gamma} = h_f = f\frac{LV^2}{D2g} \qquad (2)$$

where:

Δp = pressure drop due to viscous or turbulent losses (lbs/ft²)

γ = specific weight of fluid (lbs/ft³)

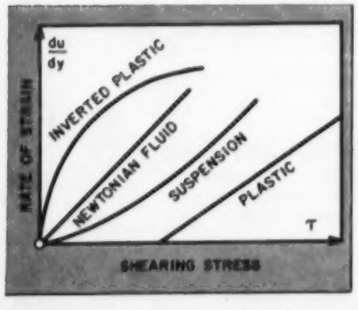

Fig. 2–Stress versus rate of strain diagram for various types of material. Sludges behave as plastics.

h_f = frictional head loss (ft)

f = friction factor (dimensionless)

L = conduit length (ft)

D = pipe diameter (ft). For a non-circular conduit, $D = 4_R$ (R = hydraulic radius)

$V = \frac{Q}{A}$ = average flow velocity (ft/sec)

Friction factor f is our catch-all term that takes account of nature of the fluid, conduit roughness, and so on. Eq. 2 does not contain fluid viscosity. This is because it is basically a turbulent flow equation. We shall find that viscosity enters directly into the determination of laminar-viscous friction factor.

Sometimes we wish to know more about the nature of flow in a conduit, such as velocity distribution in the cross-section. In fully developed flow, at some distance from the conduit entrance or change in section, velocity is highest in the center and decreases toward the wall. The center velocity is thus greater than average velocity V, and we sometimes use the ratio of these two velocities (pipe factor $P = V/u_c$, where u_c is center or maximum velocity) as an indication of the nature of velocity distribution.

Expressions for velocity distribution, head loss for laminar-viscous pipe flow, and certain other flow situations can be derived from eq. 1, once we have a relationship for shear stress variation. For fully developed flow, in which velocity profile does not vary with position along the pipe, this is obtained simply with the aid of mechanics. Consider a concentric cylindrical element (radius r) of fluid inside a pipe (diameter D) as shown in fig. 3. In length L of conduit, pressure drops from p_1 to p_2 due to friction loss. Since gravitational effects balance out, forces on the cylindrical element are the pressures on the ends and the shear stress along the sides. Since these must be in equilibrium,

$$p_1\pi r^2 - p_2\pi r^2 = \Delta p\ \pi r^2 = \tau 2\pi rL$$

whence

$$\tau = \frac{\Delta p r}{2L} = \frac{\Delta p}{2L}\left(\frac{D}{2} - y\right)$$

This linear relationship for the shear stress applies to either laminar-viscous or turbulent flow. If we substitute it into our viscosity relationship, eq. 1, and perform the indicated integration, we find that the velocity distribution (for fig. 3) is parabolic.

$$u = \frac{\Delta p}{4\mu L}(Dy - y^2) \qquad (3)$$

The constant of integration has been evaluated by utilizing the fact that velocity at the wall is zero. At the center $y = D/2$ and maximum velocity is $u_c = \Delta pD^2/16\mu L$. Average velocity is found through integration of eq. 3 across the pipe, and turns out to be $V = \Delta pD^2/32\mu L$. Pipe factor for laminar flow in a circular conduit is thus $P = \frac{V}{u_c} = 0.50$.

The pressure loss relationship is found by rearranging the expression for the mean or average velocity.

$$\Delta p = 32\mu LV/D^2 \qquad (4)$$

This is known as the *Hagen-Poiseuille law*. The loss varies with the first power of the velocity and inversely with the second power of the diameter, rather than as indicated by eq. 2 for turbulent flow. In spite of this fact, we use eq. 2. Substitution of eq. 4 into eq. 2 gives us the following relationship for the pipe friction factor in laminar-viscous flow,

$$f = \frac{64}{\frac{VD\rho}{\mu}} = \frac{64}{\mathbf{R}} \qquad (5)$$

The denominator in the above equation, $\mathbf{R} = VD/\nu$, (where ν is kinematic viscosity) is the *Reynolds number*, one of the fundamental dimensionless parameters of fluid mechanics. If its value is less than 2000 to 2500 we find that the conduit flow is laminar-viscous, and eq. 5 may be used to determine the friction factor for use in eq. 2. At higher Reynolds numbers the flow is usually turbulent.

EXAMPLE: Air is flowing through 100 ft of ¾-in. pipe at a speed of 2.5 fps. For the pressure and temperature at which it is flowing, the specific weight is 0.076 lbs/ft³ and the kinematic viscosity is $1.5\text{x}10^{-4}$ ft²/sec. What is the pressure drop and the velocity along the centerline?

SOLUTION: It is first necessary to calculate the Reynolds number at which the air is flowing to ascertain if the flow is laminar.

$$\mathbf{R} = \frac{VD}{\nu} = \frac{2.5 \times \frac{0.75}{12}}{1.5 \times 10^{-4}} = 1040$$

The flow is definitely laminar and the friction factor is $f = 64/1040 = 0.0615$. We can now calculate the head loss with eq. 2,

$$h_f = f\frac{L\,V^2}{D\ 2g} = 0.0615 \times \frac{100}{\frac{0.75}{12}} \times \frac{(2.5)^2}{64.4} = 9.6\text{ ft.}$$

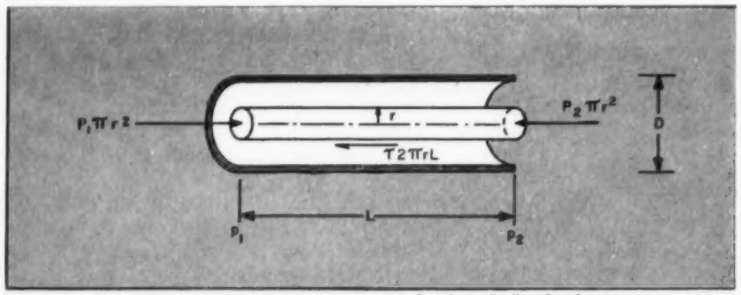

Fig. 3–Diagram of forces acting on cylindrical fluid element in pipe. Through length L, pressure drops from p_1 to p_2 due to friction loss.

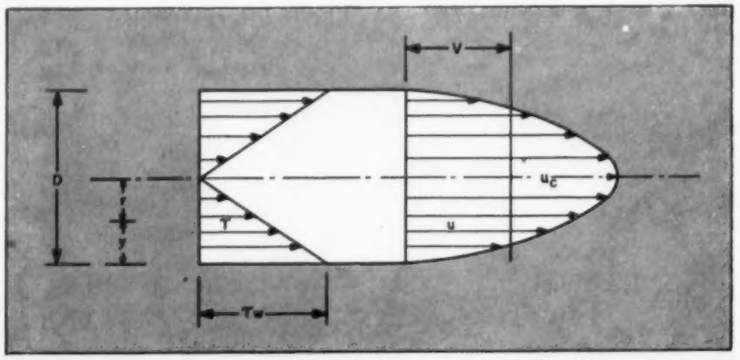

Fig. 4–Diagram of shear stress and laminar velocity distribution in a pipe. Average flow velocity is found by integrating eq. 3 across the pipe.

Pressure drop is

$$\Delta p = \gamma h_f = 0.076 \times 9.6$$
$$= 0.73 \text{ lbs/ft}^2$$

Since flow is laminar, centerline velocity is twice the average or 5 ft/sec.

The Hagen-Poiseuille law applies to circular pipes and is independent of conduit wall roughness. Although we are most interested in pipes of circular cross-section, on occasion we wish to calculate flow relationships for other conduit shapes. In turbulent flow situations, the effect of cross-sectional shapes is adjusted by means of the hydraulic radius concept. Hydraulic radius R is defined as the ratio of cross-sectional flow area to wetted perimeter. Since for a circular shape R = D/4, for non-circular shapes the equivalent diameter Deq = 4R is substituted in place of D in our head loss relationship (eq. 2) and in the Reynolds number expression. This is satisfactory when flow is turbulent. In laminar-viscous flow, however, it is not correct.

Relationships for velocity distribution and pressure drop for laminar-viscous flow in non-circular conduits have been found analytically for many simple shapes. Thus, the two-dimensional case of flow between two parallel plates is solved by the same procedure as indicated for the circular pipe. Shear stress variation is linear and velocity distribution is therefore parabolic. However, the mean velocity is now two-thirds of the maximum. Although the procedure of using four times the hydraulic radius in place of the diameter in eqs. 2 and 5 is not correct, we use it for convenience but generalize eq. 5 and let the constant depend upon the cross-sectional shape.

$$f = \frac{C}{R} \qquad (5a)$$

where C depends upon the cross-sectional shape. For the flow between parallel plates, C = 96. This flow case represents the limiting situation for a wide rectangular duct or for the annulus between two concentric cylinders. For other conduit cross-sectional shapes, the analytical solution becomes more complicated. Fig. 5 indicates the manner in which the coefficient C varies from 48 to 96 depending on the aspect ratio and shape of conduit cross-section.

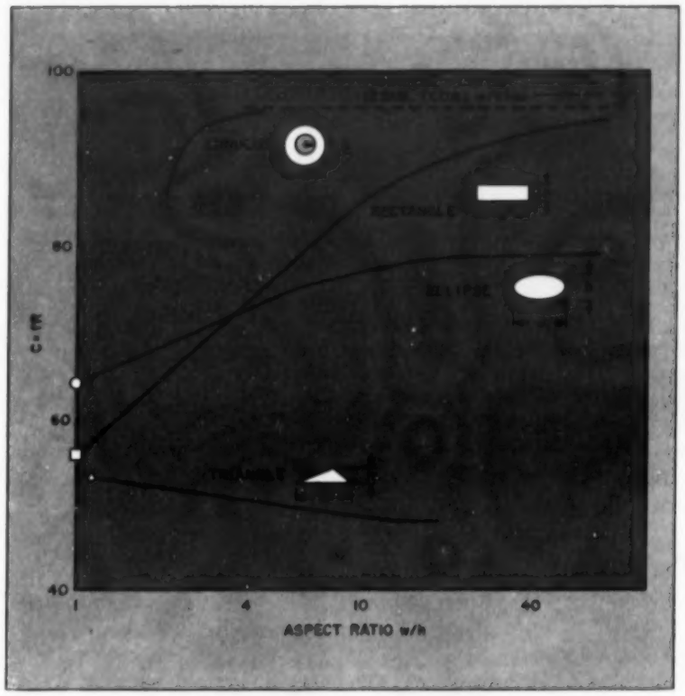

Fig. 5—Laminar friction factor coefficient for varioous conduit shapes Co-efficient may vary between a low of 48 and 96 (parallel plates).

Viscosity also has a very important effect on the motion of bodies through fluids. At low speeds, the effect is direct and subject to analysis. The classic example is that of the terminal velocity of a sphere falling in a viscous fluid.

$$V = \frac{1}{18} \times \frac{\rho' - \rho}{\mu} g D^2 \qquad (6)$$

This is known as *Stokes Law*, with ρ' representing density of the sphere and ρ that of the fluid. In fluid mechanics, we commonly use the drag coefficient to evaluate the force on a body moving through a fluid.

$$F = C_D \frac{\rho V^2}{2} A \qquad (7)$$

where A is the projected area, i.e., the cross-sectional area of the body normal to the direction of motion ($\pi D^2/4$ for a sphere). Using this form of expression, Stokes law becomes

$$C_D = \frac{24}{\mathbf{R}} \qquad (8)$$

where the Reynolds number **R** is based on the relative velocity of motion through the fluid, divided by the kinematic viscosity of the fluid. As long as the Reynolds number is low (below 0.5) this law applies.

EXAMPLE: Estimate the terminal velocity of a 40-micron diameter dust particle in standard air. Specific weight of dust is about 120 lb/ft^3 and a micron is 10^{-6} meters or 3.28×10^{-6} ft.

SOLUTION: Although we could solve this problem via the drag coefficient and Reynolds number, it would require a trial and error approach. We will therefore assume that Stokes law (eq. 6) is applicable and later verify this through calculation of the Reynolds number. The following quantities are available for insertion into eq. 6,

for the particle:

$$\rho' = \frac{\gamma}{g} = \frac{120}{32.2}$$
$$= 3.72 \text{ lb-sec}^2/\text{ft}^4$$
$$D = 40 \times 3.28 \times 10^{-6}$$
$$= 1.3 \times 10^{-4} \text{ ft}$$

for the fluid (air):

$$\rho = 0.00236 \text{ lb-sec}^2/\text{ft}^4$$
$$\mu = 4 \times 10^{-7} \text{ lb-sec/ft}^2$$

therefore

$$V = \frac{1}{18} \times \frac{\rho' - \rho}{\mu} gD^2$$
$$= \frac{1}{18} \times \frac{3.72}{4 \times 10^{-7}} \times 32.2 (1.3 \times 10^{-4})$$
$$= 0.217 \text{ ft/sec}^2$$

Before accepting this as the correct answer, we must assure ourselves that Stokes law is applicable. This is done through calculation of Reynolds number.

(continues on page 28)

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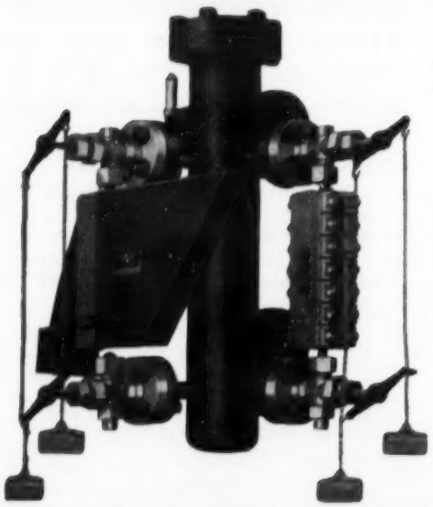

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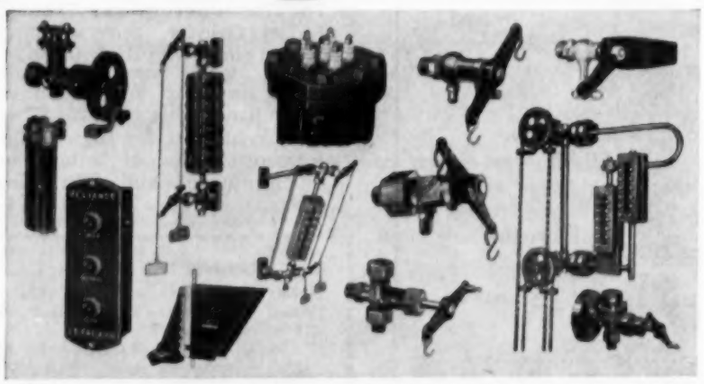

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Fluid mechanics

. . . starts on page 21

$$R = \frac{VD\rho}{\mu}$$

$$= \frac{0.22 \times 1.3 \times 10^{-4} \times 0.00236}{4 \times 10^{-7}}$$

$$= 0.17$$

Although this is near the upper limit of applicability for Stokes law, the calculated terminal velocity of the dust particle is fairly reliable.

If, in this example, the Reynolds number had been considerably above the range of applicability of Stokes law, it would have been necessary to use empirical information on the variation in drag coefficient C_D with Reynolds number **R**. Such information is indicated in

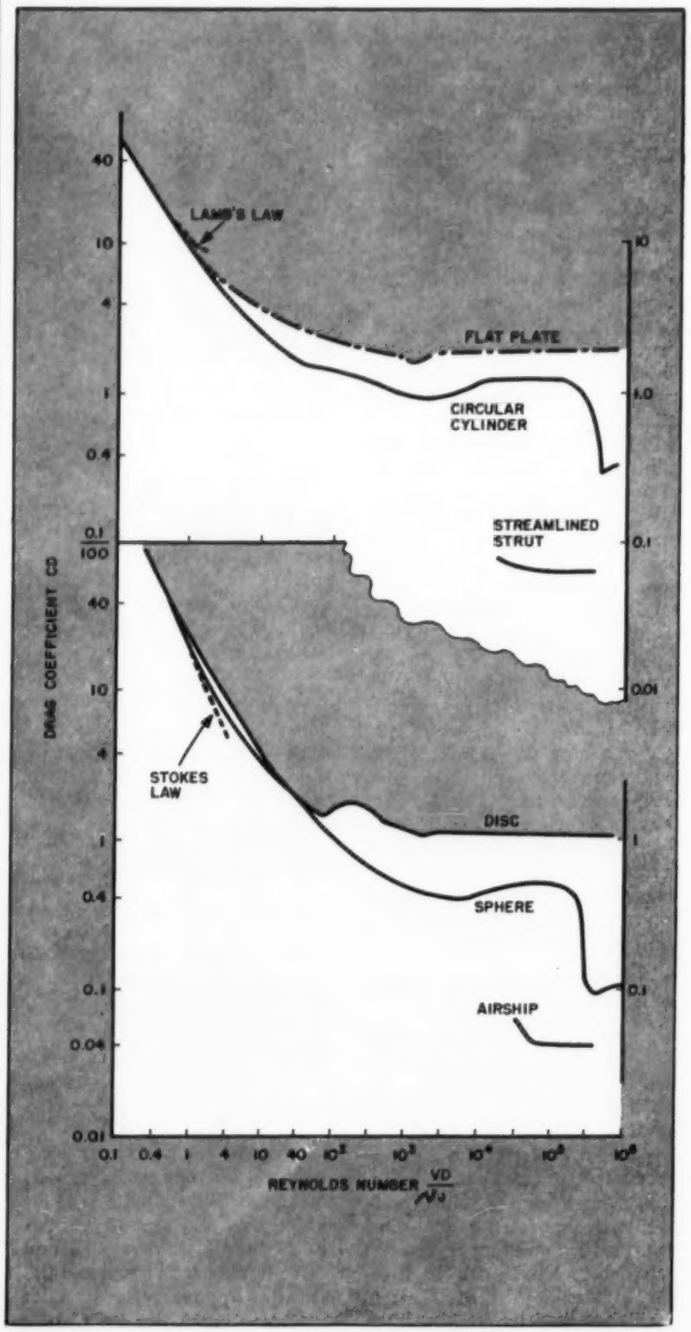

Fig. 6—Drag coefficients of some simple bodies as a function of Reynolds number. If Stokes law doesn't apply, such chart is used.

fig. 6 for a few common body shapes. It is apparent that for the higher Reynolds numbers, drag coefficient rapidly approaches a constant value, which is why it is so commonly used. For two-dimensional body shapes, an analytical solution has been obtained for the circular cylinder by Lamb. This is represented approximately by

$$C_D = \frac{12}{R\,(1-\log R)} \qquad (9)$$

If D is taken as the width of the plate, this law also gives us the drag coefficient of a long plate held normal to the moving fluid, just as eq. 8 gives that of a disc similarly positioned. Of course, both these relationships are limited to the Stokes range (to low Reynolds numbers).

separation and its effect on flows

We have reached the point in our discussion of body drag or resistance, and to some extent in our discussion of conduit flow, beyond which our theories and analysis cannot go. These flow conditions can only be handled with the aid of empirical information, such as presented in fig. 6. An understanding of the phenomena involved in the flow, however, does help us in interpreting and generalizing our knowledge. Using similarity considerations prevents this phenomenological approach from becoming a mere collection of empirical formulas, each of limited applicability. We have already utilized the basic dimensionless similarity parameter characterizing incompressible fluid resistance, the Reynolds number. When the drag coefficient, another dimensionless parameter, is plotted as a function of Reynolds number, we find that a unique relationship results for a given body shape, no matter what the fluid or size of body.

Beside giving us a unique relationship for the drag coefficient, using Reynolds number as our basic similarity parameter gives us a frame of reference for describing the flow about the body. At a given Reynolds number, the flow pattern about a body of given shape is the same no matter what the size or speed of the body. It is, of course, only for this reason that the drag coefficient is a unique function of Reynolds number. Thus, in the

(continues on page 30)

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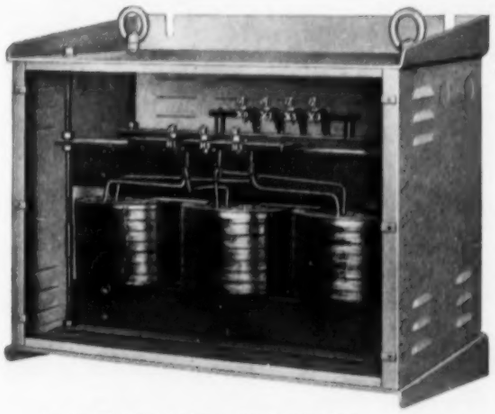

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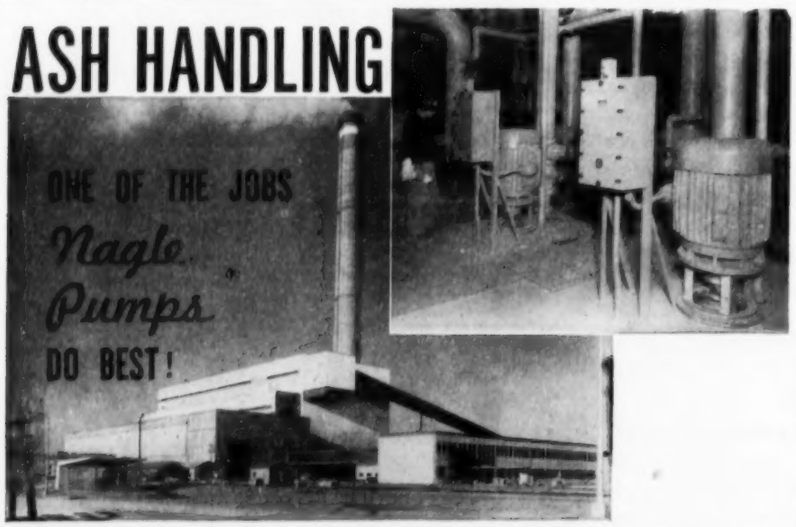

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Fluid mechanics

. . . starts on page 21

Reynolds number range from about 10^3 to over 10^5, flow about the cylinder or sphere is characterized by a separation originating at a point about halfway about the body, as sketched in fig. 7a. This leads to the essential constancy in the drag coefficient.

In the case of very blunt bodies, of which the disc and flat plate are extreme examples, the separation point is fixed by the geometry and the drag coefficient is constant at all Reynolds numbers above the Stokes range. On the other hand, a streamlined body as indicated by fig. 7c, is designed to avoid or inhibit separation. In conduit flow, the same type of effects occur. Valves and other fittings with sharply defined boundaries have essentially constant loss coefficients, but well-rounded fittings (such as a Venturi meter) have loss coefficients varying with Reynolds number.

The nature of flow about our blunt bodies (cylinder and sphere) in the range between the Stokes range ($R < 1$) and that for which the drag coefficient is essentially constant ($R \gtrsim 10^3$), can be described qualitatively. The flow gradually changes from being nearly symmetrical about the body to one elongated in the rear and then to separated flow. Along in the sequence of this transition, vortices form behind the body, and starting at a Reynolds number of about 20 for the cylinder, the vortices are shed alternately from the two sides. These are known as the *von Karman* vortex trail. They produce a periodic lateral force on the cylinder which, although not large, can lead to serious structural problems. If the frequency of this force approaches the natural frequency of the structure, it may shake itself to pieces. Serious problems of this nature have occurred with large steel smokestacks, bridges, pipeline crossings over rivers, and even for large missiles or rockets standing on their launching sites. Such problems are unexpected since the fluid velocities involved are often low, maybe only a few miles per hour. The von Karman vortex trail is easily seen in the flow behind cylinders at lower Reynolds numbers. At higher Reynolds numbers, the trail is masked by the predominant effect of separation and turbulence, but its effect has been noted on large smokestacks of a power plant at Reynolds numbers of about 10^7. The frequency of vortex shedding and hence of the oscillating force has been found to be roughly $f = 0.2V/D$.

EXAMPLE: A power plant stack is 2 ft dia and 200 ft high. What is the direct wind force on the stack in a 6 mph breeze, and what is the forcing frequency of the lateral oscillation due to the von Karman vortex trail?

SOLUTION: We first calculate Reynolds number in order to evaluate the drag coefficient. Relative air velocity is 8.8 ft/sec, and assuming standard air, the kinematic viscosity is 1.4×10^{-4} ft^2/sec.

$$R = \frac{VD}{\nu} = \frac{8.8 \times 2}{1.4 \times 10^{-4}} = 1.3 \times 10^5$$

From fig. 6 or a similar plot, the drag coefficient is $C_D = 1.2$. Since area $A = DL = 400$ ft^2 and dynamic pressure $\rho V^2/2 = 0.091$ lbs/ft^2, force on the stack is

$$F = C_D \frac{\rho V^2}{2} A$$

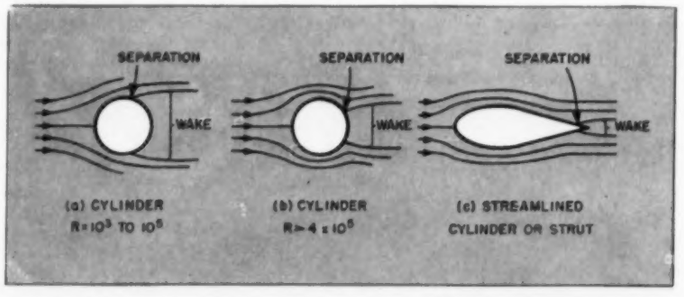


Fig. 7—Flow patterns about bodies as affected by shape and Reynolds number. Streamlined body is designed to inhibit separation.

$= 1.2 \times 0.091 \times 400$
$= 44$ lbs.

The frequency of the alternating lateral force from the vortex trail is $f = 0.2 \times 8.8/2 = 0.88$ cps. To avoid resonance, it is vital that the natural frequencies of the stack be far removed from this. One cannot always achieve this aim, and it may be necessary to guy or stiffen the stack or to add damping to keep the amplitudes of motion down.

occurrence of turbulence

Above a certain critical Reynolds number, the flow about a body or through a conduit becomes turbulent. The motion is no longer regular and laminar, but becomes random fluctuations that may be visualized as a lot of eddies being carried along in the fluid. The lateral diffusive power of turbulence is such that an "effective viscosity" is produced that is much larger than that we have been considering so far. We cannot say, however, that our usual viscosity has been replaced by turbulence. At most, we can say that it has been superseded. It is still important to the motions, even though it is not greatly in evidence. Thus, although energy loss is much greater in turbulent flow than in laminar flow, it is our usual viscosity that is ultimately responsible for converting turbulence energy into heat.

Turbulence may be described as an irregular eddying motion in which the instantaneous velocity at a point in the flow varies randomly in direction and magnitude about some average velocity. Smoke issuing from a chimney is a good example of this situation. Although in detail the motion fluctuates randomly, a definite average or mean motion is apparent.

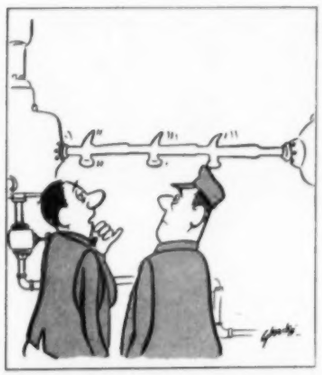
Since we discuss turbulent motion in terms of a temporal average or mean velocity, eq. 1 relating shear stress to velocity gradient no longer applies. For use with the mean velocities in turbulent motion we can replace μ in eq. 1 by a proportionality factor called the eddy viscosity. But this factor is not a fluid constant and varies across the flow. Our approach to the analysis of turbulent flows is therefore basically empirical, supplemented by similarity considerations and rational synthesis.

In both types of flow we have discussed, flow through conduits and flow about bodies, turbulence appears at a certain point and modifies the flow. Flow about a body suffers a radical change with the onset of turbulence. In this case, for blunt bodies at least, the result is beneficial. At a Reynolds number of 3 or 4×10^5, flow in the boundary layer near the surface of a sphere or cylinder changes from laminar to turbulent. Fluid in the turbulent boundary layer is able to flow further around the rear of the body and the separation point is delayed, as indicated by fig. 7b in comparison with fig. 7a. The smaller separated region at the rear results in a considerably smaller drag coefficient as shown in fig. 6.

velocity distribution is not parabolic

In the case of conduit flow at Reynolds numbers above 2000 to 2500, we have noted that laminar-viscous flow becomes turbulent. In turbulent pipe flow, velocity distribution is no longer parabolic as given by eq. 3, but is much flatter in the central region due to the turbulent eddy viscosity being much higher than the fluid viscosity. Head loss, instead of varying with the first power of the average flow velocity, varies nearly with the second power. The ramifications of these differences are so great that we will leave their discussion until next month. ♦ ♦

Next month, Professor Robertson will continue by discussing Turbulent Conduit Flow. This is the type of flow that we are most familiar with. Be sure to look out for Part V in the December issue.



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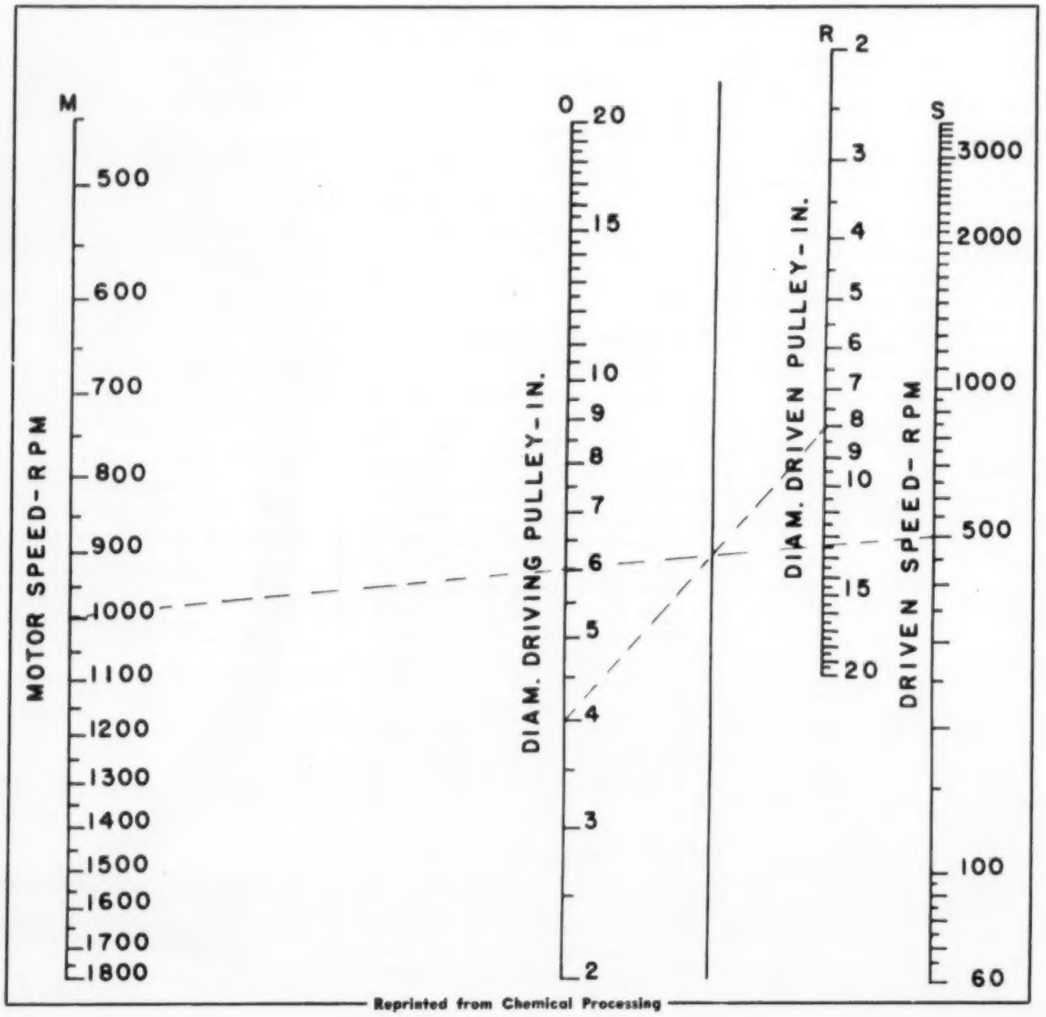

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(continues on page 34)

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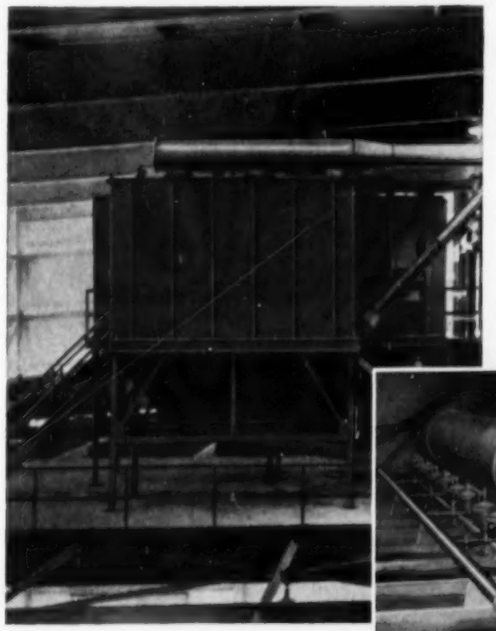
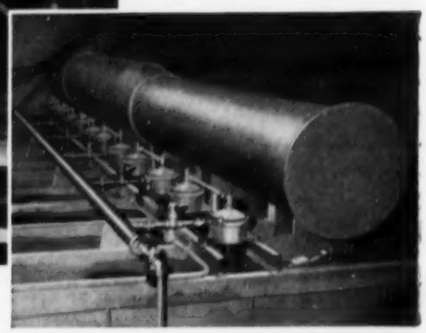


through automatic bag cleaning



Plants running full blast can ill-afford down time for equipment repairs and maintenance. Dust collection around the clock without interruption is commonplace with Norblo Automatic Bag Type Arresters.

Complete time-cycles for progressive automatic bag shaking are controlled by highly efficient electric timers. Only one compartment is cut out at a time, and that for just a few seconds, with *no* drop in efficiency for the installation as a whole. Norblo's compartment construction is the time-saving solution to inspection, maintenance and repair in busy plants . . . For "good housekeeping" or for salvage, Norblo Automatic installations have many design advantages wherever continuous high recovery of industrial dusts and fumes is important.

It pays you to write at once for latest information on Norblo Automatic Bag Type Dust Arrester that assures constant high efficiency dust handling.

THE NORTHERN BLOWER COMPANY

6422 Barberton Ave., Cleveland 2, Ohio OLympic 1-1300

Norblo ENGINEERED DUST COLLECTION SYSTEMS FOR ALL INDUSTRIES

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Power Industry

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featuring all these unique elements:

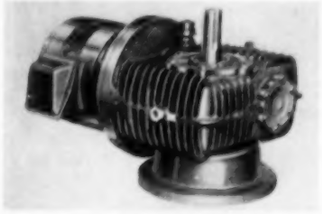
- TERSE, VITAL EDITORIAL
- HAND-PICKED CIRCULATION
- 'EXECUTIVE' FORMAT
- QUALITY READERSHIP
- HIGH READER ACTION

PI new developments

. . . starts on page 33

1004-Mount gearmotors on floor, ceiling, wall

Cone-Drive gearmotors in standard or hollow shaft models have base for floor, ceiling, or wall mounting. Gearmotors are double-reduction units with a helical primary and a double-



enveloping worm gear secondary. Unique "hour-glass" worm meshes with throated gear. One-eighth of the gear teeth are always in mesh. High area contact between worm and gear teeth spreads load over a greater area. Gearmotors are 1 to 15 hp for standard NEMA D-flange motors. Output speeds are 7.3 to 525 rpm. CONE DRIVE GEARS DIV., MICHIGAN TOOL CO.

1005-Precipitator control has no moving parts

Transistomatic precipitator control system is completely sealed in electronic potting compound to keep it unaffected by moisture, dust, humidity. New sensing principle makes a dy-

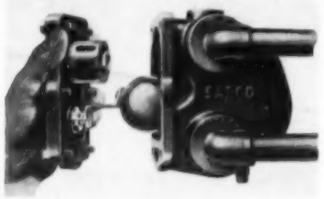
namic, continuous system that evaluates surge current rate to integrate total surge current in relation to time. Entire unit operates without tubes, relays, or other moving parts requiring maintenance or periodic lubrication. Entire unit has life-time guarantee. WESTERN PRECIPITATION CORP.

MORE INFORMATION

For more detailed free information on these products just circle the key numbers on a Reader Service card between pages 50 and 51.

1006-Steam trap design eases maintenance

Operating element of FT steam trap can be removed for inspection and maintenance without disturbing inlet and outlet connections to trap body. Operating elements consist of stainless steel valve mechanism, copper float, and bronze thermostatic air vent. Valve discharges condensate at steam temperature continuously and without



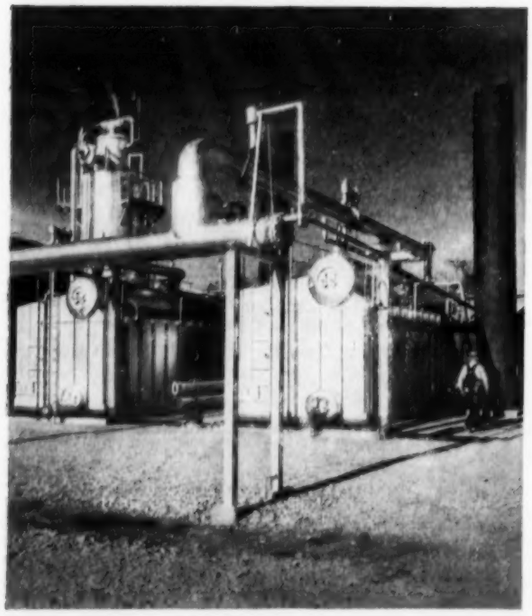
shock. Air vent needs no adjustment to compensate for pressure changes – removes all air and incondensable gases without letting steam escape. Trap is suitable for all applications requiring accurate control to 125 psig. SARCO CO., INC.

1007-Building board won't burn, rot, or mold

Asbestolux is lightweight building board made entirely of inorganic material for complete resistance to fire, heat, rot, mold, and termites. Fiber asbestos is bonded chemically with a special silica in a high-pressure

steam process to form a board weighing one-third less than cement asbestos boards and giving five times more insulation. Can be sawed, nailed, or fastened with screws. Resistance to heat and insulating properties make Asbestolux ideal thermal barrier for applications where heat is intense. High dielectric strength makes it suitable both as an electrical component and as a protective material. NORTH AMERICAN ASBESTOS CORP.

PACKAGED STEAM by FW



helps load more than 7,000,000 gallons of oil in less than 3 months

When U. S. refiners recently were required to meet a sudden, extended demand from Europe for oil, one of the key points of supply was the Magpetco Terminal of Magnolia Petroleum Company. With storage capacity for some 4½ million bbl of petroleum products, this southeastern Texas tank farm was a "natural" for emergency use as a crude oil outlet point—7,000,000 gallons of crude oil were loaded in less than 3 months.

The two Foster Wheeler Packaged Steam Generators shown at left not only met all the normal load requirements but demonstrated ample reserve capacity for emergencies. They provided a reliable source of steam which was essential to operate the many large reciprocating pumps and to heat heavier oil in the storage tanks to facilitate pumping.

Chosen by Magnolia engineers to replace outmoded steam equipment at the terminal, the units are installed outdoors. Casings are of all steel welded construction with weather proof insulation over the drum ends. Each unit delivers 30,000 lb of steam per hour at 150 psi. Dimensions are: 10′ x 28½′ x 12′ high.

FW Packaged Steam Generators are available in capacities from 10,000 to 62,500 lb/hr and pressures to 1300 psi. For complete information, send for Bulletin No. PG-55-3. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

Circle 815 on Reader Service card for more data

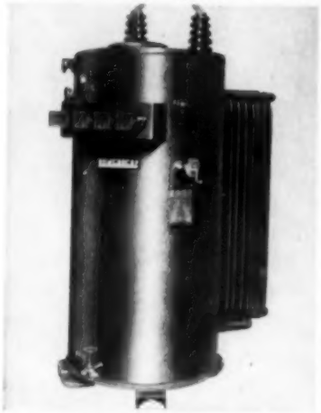
1008-PVC socket valve won't corrode

Now added to the Luncor line of polyvinyl chloride valves are Luncor socket-end valves for PVC pipelines. Socket-end valves are rated 125 wp and 140 F. Luncor PVC valves han-

dle most common corrosive solutions used in industry, chemical processing, etc. Strength-weight ratio gives them rigidity comparable to metal. LUNKENHEIMER CO.

1009-Transformers give extra protection

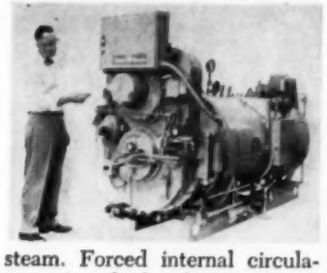
Substation transformers (Type LD) have new Lowgrocap winding design that distributes voltages more evenly, giving added resistance to voltage breakdown. Ratings are through 15 kv, 250 to 500 kva, single-phase. New design reduces transformer weight by 25%, installation area by about 35%.



Placement of new round tank with flat fin coolers away from low-voltage terminals cuts installation area. Bushing mounting is simplified. Tank is sealed by welding around bottom, making it possible to untank unit without disturbing core or coils. WESTINGHOUSE ELECTRIC CORP.

1010-Oil heater heats liquids to 600 F

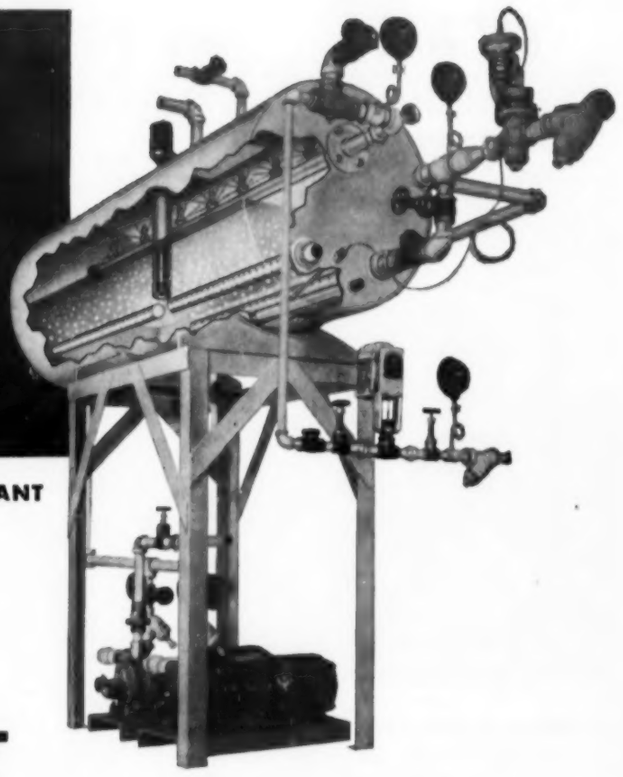
Peak-Temp is a direct-fired oil heater for heating transfer oils or other liquids to 600 F. Heat transfer oils may be circulated through coils, molds, jacketed vessels, or other heat exchange equipment for higher temperatures than would be economically obtained with high-pressure



steam. Forced internal circulation gives high-velocity flow of heat transfer oil over heating surfaces. Uniform oil temperature eliminates hot spots or oil deterioration. Heater burns gas, oil, or both. Controls are automatic. CLEAVER-BROOKS CO.

(continues on page 36)

SCHAUB "03" DEAERATOR



FOR THE SMALL TO MEDIUM STEAM PLANT

- **Combats "Return Line" Corrosion**
- **Guarantees Oxygen Removal to .03 cc/liter**
- **Simpler in Principle and Operation**
- **Pays for Itself in Savings**

HOW TO CUT CORROSION COSTS without Breaking Your Budget

If your steam needs are in the 3,000 to 30,000 lbs./hr. range the Schaub .03 Deaerator was designed with you in mind.

It is in plants of this size range — often operating at low pressure — that "return line" corrosion is most likely to be a continual costly maintenance item. A Schaub .03 Deaerator effectively combats this and at very low cost. It is equally applicable to high pressure installations.

The *big* difference between the Schaub .03 and other low-cost deaerators is that it operates *fully vented* at atmospheric pressure for better gas removal. Yet wasteful steam vapor loss is prevented regardless of load variations by the simple, but effective Schaub spray-contact vent condensing method. Other exclusive features that boost efficiency are pin-point temperature control and "live action" heating of storage water. This provides more forceful "break-away" of air molecules.

With fully vented design, no premium-cost pressure construction is needed and maintenance and operating costs are reduced to a minimum. Rust-proof Chromosoid lining adds years of trouble-free life.

NOTE: For boiler capacities up to 100,000 lbs./hr. and .005 cc/liter oxygen removal, write for Bulletin 575, describing the unique Schaub Zero-Oxygen Deaerator.

SEND FOR BULLETIN 1300

The full facts on the "hows", "whys" and basic differences in the Schaub .03 method. Filled with facts for the operating or consulting engineer responsible for boiler feedwater deaeration.

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Please send me, without cost or obligation, my personal copy of your new Bulletin 1300 on Boiler Feedwater Deaeration.

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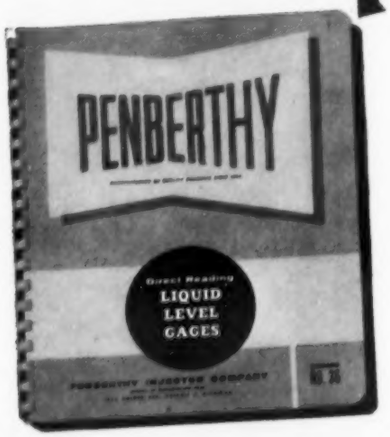
Circle 804 on Reader Service card for more data

GET THIS HANDY GUIDE TO BETTER VALVES AND GAGES



Shows complete line of Penberthy valves and liquid-level gages for power, petroleum, and process industries. Includes technical data, parts, price lists, and accessories such as:

HEATING AND COOLING GAGES... for accurate readings where liquids must be cooled or heated to obtain exact measurement.

INSTRUMENT VALVE... permits gage repair or replacement without shutdowns. Back-seating stem permits repacking under pressure.

FROST PREVENTIVE GAGE... eliminates frost build-up... assures dependable visibility. For industries where frosting interferes with accurate readings.

ILLUMINATORS ... plastic wedge distributes bright, even light along entire column. Nonglaring... dustproof for perfect illumination.

WELDING PAD GAGES ... where process conditions require observation windows as integral part of vessel.

PENBERTHY

Dept. IP

Penberthy Manufacturing Company
Division of Buffalo-Eclipse Corporation
1242 Holden Ave., Detroit 2, Mich.

Please send FREE copy of Catalog #36.

NAME_____ TITLE_____

ADDRESS_____

COMPANY_____

Circle 832 on Reader Service card for more data

IP new developments

... starts on page 33

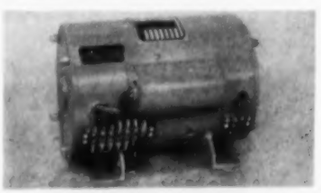
1011-Proportioner mixes, pumps compound

Chemical proportioner automatically measures and mixes surface-active wetting compound with water and pumps mixed solution to corrosion-resistant tank, then to points of application in Chem-Jet dust control system. Micro-bellows pump gives precise control over

amount of compound proportioned into the water line and permits accurate variable-flow proportioning. Pump, motor, and proportioner are in one housing. Capacity ranges include 0 to 50 gpm, 40 to 100 gpm, and 100 to 500 gpm. Standard inlet pipe sizes are 1, 1¼, and 1½ inches. The Johnson-March Corp.

1012-Lightweight, portable frequency converter

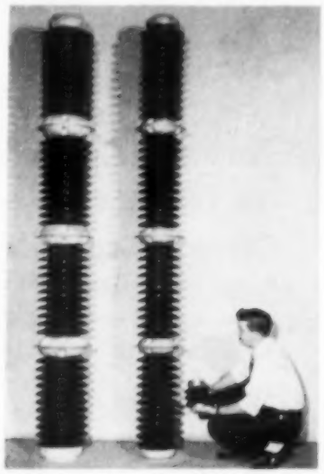
Nobrush frequency converter consists of motor and generator in single steel shell. Output is 125 va, single-phase, 400 cps. Dimensions are 9¾ by 6¾ by



8½ inches; weight is 39 pounds. Simplified design includes elimination of starting relay from motor, brushless construction. Infrequent lubrication of bearings is only maintenance needed. Motor is capacitor start and run, single-phase 115/230 volt, 60 cps. Prolonged short circuit cannot harm unit. Georator Corp.

1013-Station posts for high-voltage duty

Station post insulators for extra high-voltage switch and bus support come in two BIL series: 1300 kv withstand and 1470 kv withstand in standard or high-strength ratings. Station post assemblies are lightweight and need only 20 bolts for fast, safe assembly. Four fog-type porce-



lains with end caps cemented on porcelain in a compression grip make up each assembly. Station posts are free from radio and TV interference, puncture-proof, crack resistant, and self cleaning. Lapp Insulator Co., Inc.

1014-Glass Y-valve won't corrode

Made of Pyrex borosilicate glass, new two-inch valve handles acidic fluids of all concentrations or compositions at temperatures to 250 F. Ideal for processing acidic metallic salts, crystalline slurries, and all acids except hydrofluoric and hot concentrated raw phosphoric

acids. Low thermal expansion of glass allows sudden temperature differential of 200 F. Maximum line pressure at the valve is 50 psig. Valve weighs 9 pounds including mounting bracket. Installs in less than one square foot. Mounts in any position through 360 degrees. Corning Glass Works.

1015-Extended-shaft handle for circuit breakers

Extended-shaft handle operating mechanisms are now available for all circuit breaker frame sizes E through L, including new KM circuit breaker. New line permits mounting breakers

in cabinets or enclosures from 5⅛ through 17⅛ inches deep. Shafts can be cut to meet all depth requirements covered by full 10-inch shaft length. Shafts interlock with covers for operating safety. General Electric Co.

MORE INFORMATION

For more detailed free information on these products just circle the key numbers on a Reader Service card between pages 50 and 51.

1016-Liquid level gage is leak-proof

Magnetic gage permits measurement of liquid levels where ordinary gages with glass, gaskets, and threads would create a hazard because of escaping flammable gases or other explosive conditions. Gaging mechanism is in a stainless steel cham-

ber. Special scale outside chamber is magnetically actuated through chamber wall. Gages are built to order for pressures to 2500 psig at 600 F. Jerguson Gage & Valve Co.

1017-Double-plate clutch multiplies torque

Double-plate clutch (two Morlife plates with button facings) gives 100% more torque than single-plate clutches with Morlife plates. Used in large crawler tractors and other heavy-duty machines, double-plate clutch gives added torque with less clutch size. Double-

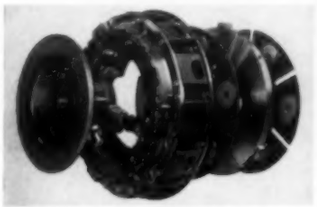
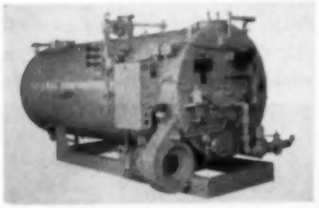


plate clutch gives 400% longer service life than conventional single-plate clutches and has 50% more heat resistance. ROCKFORD CLUTCH DIV., BORG-WARNER CORP.

1018-Package boilers have oil preheat system

Model R Amesteam generator automatic boiler combines features of Ames models X and Y with design improvements, including simplified oil preheating

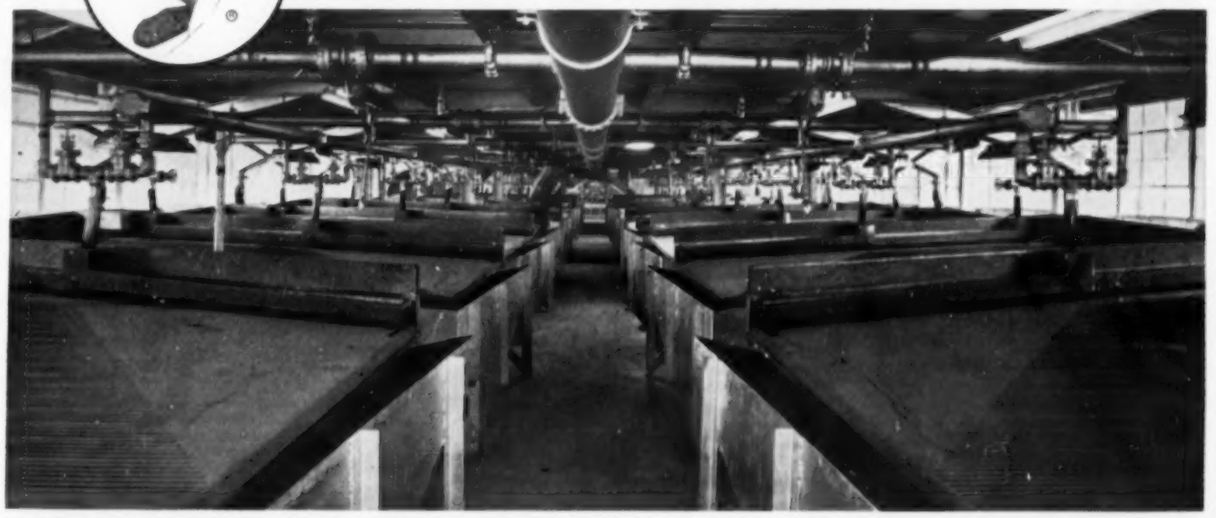


system, relocation of auxiliaries and controls. Available in sizes 10 to 150 hp for pressures to 250 psig for oil, gas, or combination oil-gas firing. AMES IRON WORKS, INC.

1019-Do away with dead spots

Belt-driven orifice ring fan for use with diesel, gasoline, steam, or electric motors has aerodynamic blades to produce high-pressure air pattern with no dead spots. Oversize shaft permits maximum horsepower. Can be used with V-belt or flat-belt pulley. Available in 10 sizes from 12 to 72 inches. Airfoil blades are of one piece construction, hollow, and larger at the hub than at the tip for even air distribution. Fan has low noise level. CHICAGO BLOWER CORP. *(continues on page 38)*

WHY CHESSIE'S RAILWAY IS FIRST IN COAL



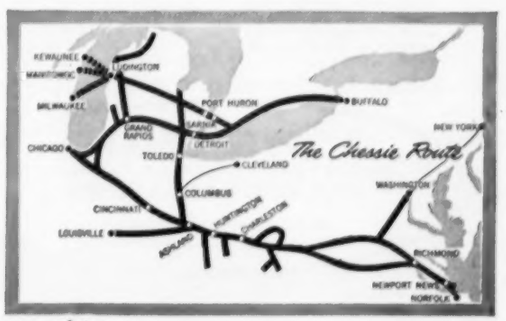
SUPERIOR COAL. This large battery of washing tables is an example of the modern methods used by producers on the C&O. The naturally superior coals found in the Chessie area can be sized and processed to meet your own particular requirements.

SUPERIOR SERVICE. With the world's largest fleet of coal cars, C&O's accelerated repair program continues to keep them in better than 99% good order. Plenty of cars, plus ample motive power and modern yards and signal systems assure prompt and efficient service.

For dependable sources of top quality coals, contact coal producers on the C&O. And for specific help in meeting your own fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake and Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

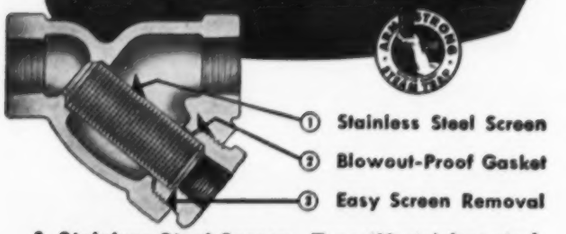
Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL



Circle 801 on Reader Service card for more data

Here's a Strainer that's a little better... YET COSTS NO MORE!



1. Stainless Steel Screen—Type 430 stainless steel screen—either perforated with .045" dia. holes, 225 per sq. in., or 20 x 100 mesh wire cloth—highly corrosion resistant.

2. Blowout-Proof Gasket—a stainless-clad asbestos gasket *inside* the strainer body is locked in place by the bushing. Only a light torque is needed for a leaktight seal.

3. Easy Screen Removal—machine screw threads instead of pipe threads make bushing and screen easy to remove.

Available in semi-steel for 250 lbs. service and in moly steel for up to 900 lbs. 900° service. Get Bulletin No. 602 for details. Write today to:

Satisfaction Guaranteed

ARMSTRONG MACHINE WORKS
8208 Maple Street, Three Rivers, Michigan

ARMSTRONG Y-TYPE PIPE STRAINERS

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THE *NEW* **REZNOR**

is the only GAS UNIT HEATER with ALL these advantages

- Clean, modern design, back as well as front . . . all controls and connections inside the cabinet.
- FlexiTemp control system with automatic two-speed fan control to provide nearly continuous air circulation and minimize temperature fluctuation (optional).
- No costly frills and gadgets . . . features which are needed only to meet special situations always separately listed and priced.
- Winter/summer switch with convenient pull cord for operation of fan alone during hot weather.
- Fan or blower models in ten sizes from 25 to 300 thousand BTU.

Write today for free catalog GN-57.

REZNOR
WORLD'S LARGEST-SELLING DIRECT-FIRED **UNIT HEATERS**
Reznor Manufacturing Company,
70 Union Street, Mercer Pennsylvania

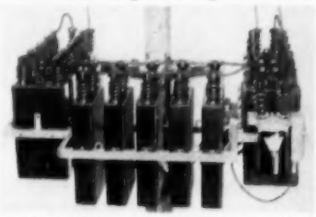
Circle 833 on Reader Service card for more data

PI new developments

. . . starts on page 33

1020-New capacitors conserve space

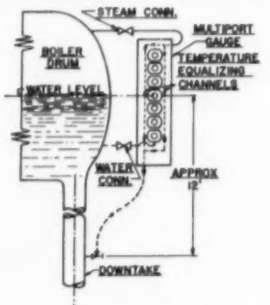
Pole-mounted cluster-type capacitor rack assemblies minimize pole bending moment, provide ample climbing space, reduce lateral space requirements,



and facilitate installation. New assemblies are rated 450, 600, and 750 kvar, at phase-to-phase voltages of 4.16 to 13.8 kv. Can be mounted with pole bands or directly to pole. A junction box is included to facilitate connections between the control and Type NR capacitor switches. Framework has keyhole slot to simplify attachment to the bracket. LINE MATERIAL INDUSTRIES, MC-GRAW-EDISON CO.

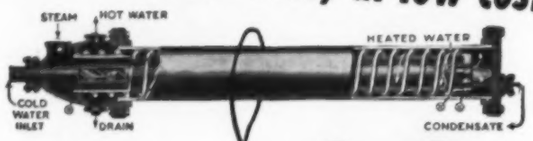
1021-Steam jacketed gage corrects for density

Steam jacket, surrounding ports in Multi-Port, Bi-Color gage, keeps gage water at or near temperature and density of



boiler drum water. This eliminates all or nearly all errors due to difference in water density between gage and drum. Circulation in the jacket is independent of circulation in the gage. Heats gage water to correspond to boiler drum water temperature. Gage is particularly important as water drums get smaller in proportion to boiler size. Lower connection on steam jacket is to boiler downtake, at least 12 ft below water level. Most effective above 1500 psi. DIAMOND POWER SPECIALTY CORP.

STEAMLINED! to heat water fast, at low cost



In the Johnson Heater, water to be heated is routed first inside, then outside, a blanket of live steam. It's full pressure steam, too; up to 150 lbs., or 250 lbs. in heavy duty types, no reducers are needed. The result: faster, more efficient heat transfer for a unit of its size. No wonder industry has found so many applications for the Johnson "Instant" Heater, in heating water and process liquids of various types.

JOHNSON "Instant" HEATER

Sizes for all needs; write for literature

The Johnson Corporation
807 Wood St. Three Rivers, Mich.

Circle 829 on Reader Service card for more data

1022-Non-segregated phase bus completely sealed

New bus structures—4.16-, 7.2-, and 13.8-kv 1200 to 3000 ampere non-segregated phase bus—is completely

sealed with cork neoprene-gasketed split half round covers. Bus is completely insulated by air and porcelain insulators. No organic materials are used for insulation. Bus is ideally suited for generator leads to transformers, for connecting transformers to switchgear assemblies, for inter-connecting switchgear assemblies, and for distribution of light and power in factories. I-T-E CIRCUIT BREAKER CO.

1023-Epoxy cement in self-metering tube

Aluminum-filled epoxy resin compound (Metalset A4) now comes in two self-metering tubes. Correct proportions of resin and low-toxicity catalyst are quickly obtained by squeezing out identical lengths of each material, then mixing. Ideal as

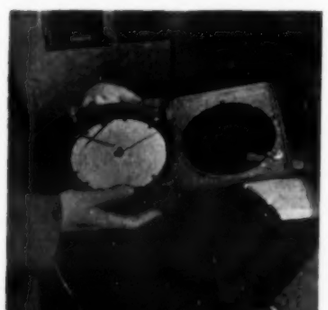
a smoothing and caulking compound, a patching material for metals, wood, plastics, and concrete, and a repair cement for leading tanks, pipes, conduits, and windows. Completely water- and oil-proof, it resists acids and alkalis and is nonflammable. SMOOTH-ON MANUFACTURING CO.

MORE INFORMATION

For more detailed free information on these products just circle the key numbers on a Reader Service card between pages 50 and 51.

1024-Charts temperatures without ink

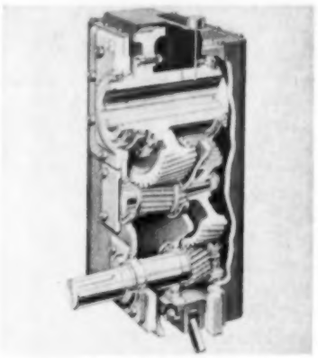
Electric graph line temperature recorder charts temperature cycles without ink. Two small mercury batteries energize



a transistor oscillator connected to stylus arm. Temperatures are recorded on a 6-inch calibrated sensitized chart on a 24-hour or 7-day rotation. Range is from –40 F to 550 F. ELECTRIC AUTO-LITE CO.

1025-Shaft-mounted drives have higher capacities

All steel 315J shaft-mounted drives are available in single reduction ratio of 5:1 and in double reduction ratios of 14:1 and 25:1. Unit ratings are 2 hp at 5 rpm to 50 hp at 359 rpm.



Maximum torque rating at low-speed shaft is 31,000 lb in. Inspection covers are provided on steel housing over bearings and helical gears. Dip stick gives quick check of oil level. THE FALK CORP.

1026-Air clutch can't leak

Three new models added to the PO air clutch line extend line to a range from 8 to 36 inches, with torque capacities to 126,000 lb-ft. New models have cartridge-type diaphragm of reinforced neoprene to eliminate leakage. Maximum torque rating in new models is 3503 lb-ft. TWIN DISC CLUTCH CO.

1027-Desuperheater holds steam temps to ± 5 F

New variable-orifice desuperheater requires no long run of piping to mix cooling water with

steam; doesn't use spray nozzles, traps, glands, stuffing box, or atomizing steam. Desuperheater is a section of steel pipe enclosing self-regulating orifice and weighted ball held in concentric position by Inconel springs. Cooling water – controlled by diaphragm-operated valve responsible to a temperature controller – enters orifice chamber at a uniform flow rate. Steam force through desuperheater raises the ball. Steam flows uniformly around the 360-degree periphery through which cooling water is introduced. Cooling water is mixed intimately and instantly into the steam for complete vaporization. Water not immediately absorbed remains in suspension until dissipated. Using a standard temperature controller with proportional and reset features, desuperheater holds final steam temperatures to ± 5 F. Desuperheater fits pipeline sizes from 2 to 14 inches, pressures to 2500 psig. Control range is limited only by ability of the cooling water control valve to modulate on light flows. – a 50-to-1 turndown is commonly achieved. COPES-VULCAN DIV., BLAW-KNOX CO.

Well, old boy, how was the vacation?

1028-High-capacity relay pilot valve

High-capacity relay pilot valve converts any high-grade commercial cylinder to a double-acting power position. Unit converts input air signals to pneumatic or hydraulic signals up to 150 psig for actuating power pistons, diaphragm motors, and rotary vanes. Input signal range is from 0 to 30 psig. HAGAN CHEMICALS AND CONTROLS, INC. ♦ ♦

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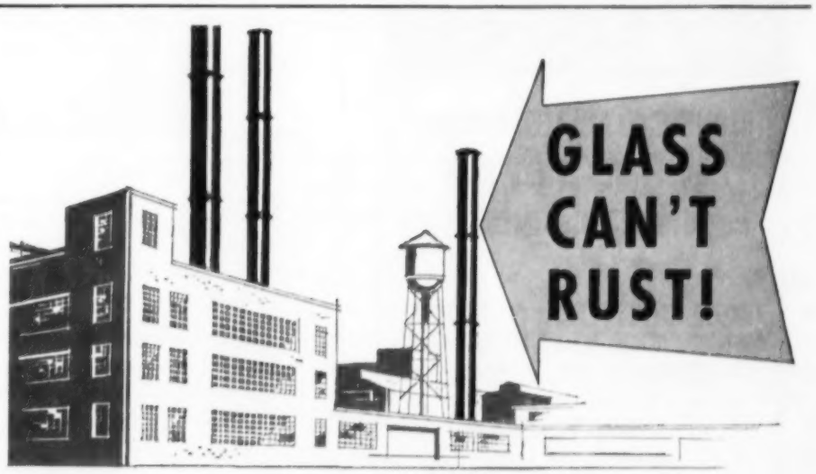

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(Splash Proof)
(Sleet Proof)
(Moisture Resistant)
(Rain Tight)
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(Hose Test)

Write for catalog No. 857W which also lists general purpose controls (NEMA 1) and explosion proof controls (NEMA 7, 9, 9A).

THE MERCOID CORPORATION
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PI handy guide to engineering literature

AIR CLEANING EQUIPMENT

900-Engineering specs on electrostatic precipitators

Precipitron models PA and PF electronic air cleaners catch smoke, micron-size dirt. Need 1/3 less face area, 50% less duct space than conventional equipment. Test efficiencies are as high as 97%. Bulletin B-1460X gives complete data. 8 pages. Sturtevant Div., Westinghouse Electric Corp.

AIR CONDITIONING, HEATING VENTILATING

901-How to estimate your air handling needs

Bulletin E-57 describes propeller fans and special related equipment. Tables help in estimating air-handling requirements, entrance and elbow losses, duct sizes. 24 pages. Aerovent Fan Co., Inc.

902-Selection tables on steam heating coils

Bulletin B-1710 describes blast heating coils, distributing tube heating coils, dual-feed distributing tube coils, and zone heating booster coils for industrial and commercial heating applications. Includes piping diagrams and performance and selection tables. 26 pages. Westinghouse Electric Corp.

903-Selecting a heavy-duty industrial blower?

Bulletin MD 102 describes specific construction, operation, and specifications of a standard line of aerodynamically designed fans. Lists specific applications for direct drive and V-belt fans. Steel-housed packaged V-belt drive unit is designed for high efficiency, long operating life, and requires a minimum space. Lists 14 different sizes ranging from 7 5/16 in. to 33 in. Handles up to 18,000 cfm. 24 pages. Chicago Blower Corp.

904-Want a quiet exhauster?

Bulletin PD-42 describes Dynafans for use where low sound level is important. Bulletin gives engineering data on direct and V-belt centrifugal exhausters, including unit size, motor hp, fan rpm, tip speed fpm, capacity in cfm. Also describes Sonotrol curb, a stable prefabricated support for the exhauster and a housing for motor- or gravity-operated dampers. Curbs are of special insulated acoustical material. 8 pages. Penn Ventilator Co.

BOILERS AND ACCESSORIES

905-Guide specifications on low-pressure heating plant

Complete guide specifications for typical low-pressure commercial heating plant are given in Bulletin AIA-30-A. Heating plant operates at 20,000 Equivalent Direct Radiation or 4,800,000 Btu/hr. Adaptable to design loads of 3000 to 24,000 EDR or 750,000 to 5,500,000 Btu/hr. Bulletin is intended as guide for consulting engineers, architects, and management men concerned with writing or approving specifications on coal-fired heating plants. 60 pages. Bituminous Coal Institute.

906-Feedwater heaters: function, design trends

Bulletin 300 covers feedwater heater applications, trends in power-plant equipment. Describes vertical and horizontal units for condensing, desuperheating, sub-cooling. 16 pages. The Griscom-Russell Co.

907-Get information on automatic package boilers

Bulletin No. 1245 provides detailed illustrations on both oil- or gas-fired units, plus illustrations and explanation of the boiler components. Lists equipment in sizes ranging from 40 to 500 hp. Describes how entire unit is designed, constructed, fire tested, insulated, and guaranteed by the manufacturer. 24 pages. Orr & Sembower, Inc.

908-Lightweight venturi desuperheater provides straight-through flow

Bulletin 6D describes new line of venturi-type desuperheaters with emphasis on lighter weight and flexibility in water inlet location. Designed to reduce superheated steam temperature to lower temperature required for operating auxiliary equipment. Made for installation as part of the steam line, they provide straight-through flow. Schutte and Koerting Co.

BUILDING MATERIALS

909-Technical data on Croloy steel pipe

Technical data on analysis mechanical and physical properties, fabrication, heat treatment, and maximum working pressures for various applications at different metal temperatures for Croloy steel pipe, tubing, and welding fittings are

Handy Guide Subject Index

Air cleaning equipment 60
Air conditioning, heating, ventilating 40
Boilers and accessories 40
Building materials 40
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Corrosion control 41
Electric distribution 42
Electric generation 43
Electric utilization 43
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Heat exchangers 43
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Maintenance items 45
Materials handling (bulk) 45
Nuclear 45
Pumping equipment 45
Traps, strainers, and separators 45
Valves and regulators 45
Water supply and treatment . 46

given in two bulletins. Bulletin 145-A gives data on Croloy 2-1/4, an intermediate alloy steel with 2-1/4% chromium, 1% molybdenum, for high-temperature service. Bulletin 152-A describes Croloy 1-1/4, an intermediate alloy steel with 1-1/4% chromium, 1/2% molybdenum. Each bulletin is four pages. TUBULAR PRODUCTS DIV., THE BABCOCK & WILCOX CO.

910-Complete information on purchasing fasteners

Detailed information on a complete line of stainless steel fasteners is contained in bulletin 2M-8-57. Includes illustrations, thread and design specifications, and availability for a variety of corrosion-resistant metals. Lists engineering data relating to composition, properties, applications. 52 pages. ALLMETAL SCREW PRODUCTS INC.

COMPRESSED AIR

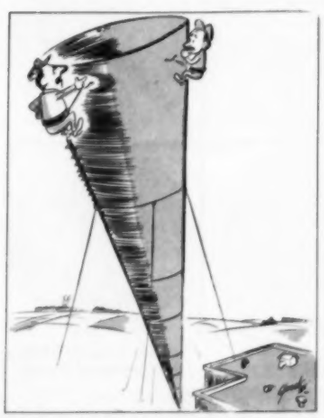
911-Manual on industrial air compressors

Natural force-balance design of M-Line industrial air compressors assures vibration-free operation. Bulletin M-81 gives complete engineering specifications, operating and installation details, complete data on models and components available. 44 pages. THE COOPER-BESSEMER CORP.

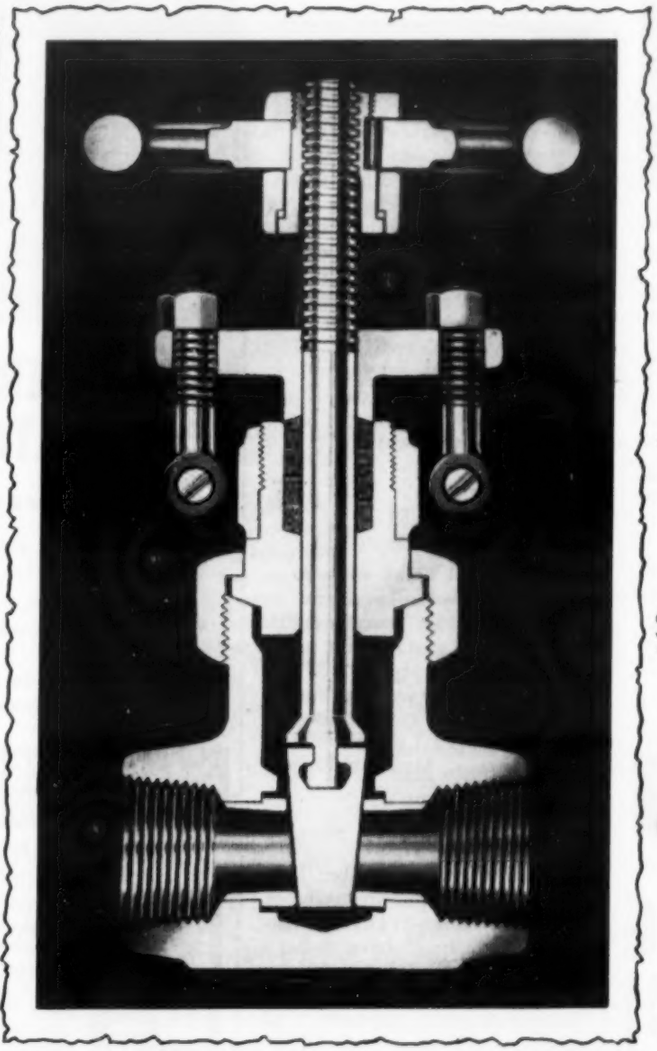
CORROSION CONTROL

912-Control corrosion with dispersion coatings

Halofluorocarbon dispersion coatings for industrial corrosion control and contamination pre-



But I thought you brought the paint!



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handy guide

. . . starts on page 40

vention are described in bulletin "Kel-F". Describes chemical resistance, thermal stability, toughness, flexibility, abrasion resistance, and dielectric strength of coatings. Materials can be coated with dispersions up to temperatures of 475 to 515 F. Dispersions are applied by spraying, spread-coating, and dip-and-flow. 4 pages. MINNESOTA MINING & MANUFACTURING CO.

ELECTRIC DISTRIBUTION

913-Horizontal break switches solve switching problems

Bulletin PSE4 describes PH two-insulator switches for service at voltages of 7.5, 15, 23, 34.5, 46, and 69 kv. Continuous current-carrying capacity is 600 amps. 12 pages. LINE MATERIAL INDUSTRIES, MCGRAW-EDISON CO.

914-Vertical-break power switch data

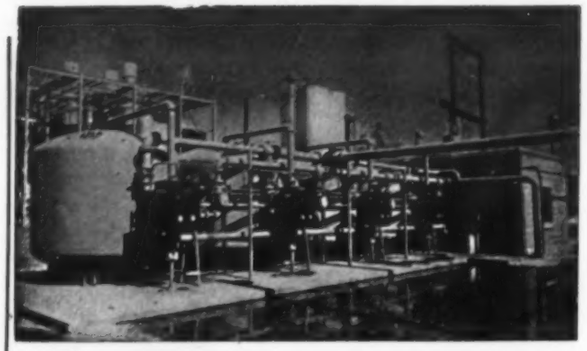
Bulletin PSE2 describes PV2 vertical-break power switches for high-voltage transmission circuits. Switches have voltage ratings of 69H, 115 and 161 kv at 600 or 1200 amps continuous current-carrying capacity. 12 pages. LINE MATERIAL INDUSTRIES.

915-Engineering data on germanium rectifiers

Bulletin GPR-2 gives data on germanium power rectifier junctions with average rectified dc current per junction of 150 to 670 amps. Junction voltage ratings are 20 to 85 volts rms. Handy fold-out section permits placing circuit diagram table opposite individual junction specifications. 14 pages. INTERNATIONAL RECTIFIER CORP.

916-Complete list of aluminum power connectors

Informative tables, charts, technical articles, and additional information are compiled in catalog No. 1. Consists of 8 sections of aluminum connectors, 158 different types, more than 7000 new items, all indexed for easier selection. Includes extensive data section. 130 pages. ROYAL ELECTRIC MANUFACTURING CO., INC.



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917-Selection guide for transformers

Tables and drawings listed in this book give high and low voltages, taps, Kva, classes, overall dimensions, and approximate weights. Lists the complete line of single-phase, 15,000 volts and below, 167 Kva and below, Type OS distribution transformers. Includes pictures of modern production and testing facilities for manufacturing these transformers. 16 pages. DELTA-STAR ELECTRIC DIV., H. K. PORTER CO., INC.

ELECTRIC GENERATION

918-Battery maintenance repair manual

Bulletin GB-1599A, "Battery Users Manual," is designed to help plant engineers, superintendents, and foremen to organize and conduct battery training course for plant personnel. Reviews battery theory and construction, selection, charging methods and equipment, testing techniques. 44 pages. GOULD-NATIONAL BATTERIES, INC.

ELECTRIC UTILIZATION

919-How capacitors cut power costs

Why, where, and how of industrial capacitor use is given in Bulletin GEA-5632B. Describes units and equipment available; discusses problems and solutions in selection of industrial capacitors. Tells how capacitors lower power costs, release system capacity, improve voltage levels, and reduce power losses. 12 pages. GENERAL ELECTRIC CO.

920-No weather problems with these motors

Bulletin No. 2050 describes open drip-proof motor, in NEMA frames 364 through 505. Stresses such motor features as "climatized" enclosures that provide all-weather security, improved thrust bearing design, metered lubrication, and protected bearing system. Lists full motor specifications, together with a cutaway drawing of each motor. 4 pages. THE LOUIS ALLIS CO.

921-Motor starters, contactors for pumps, fans, controls

Motor starters and contactors in sizes 4, 5, and 6, 50 to 400 hp, are described in Bulletin 14B8615. May be used with almost all types of drives. Contactors have ACBO arc-centering blowout to eliminate need for conventional blowout coils. 12 pages. ALLIS-CHALMERS MANUFACTURING CO.

922-Data on fail-safe electric brakes

Bulletin 6293 describes advantages of Power-Safe electric brakes for industrial applications. Data aids in selecting brake from complete line available. Summary of operating characteristics, torque characteristics, and controls is included. 36 pages. WARNER ELECTRIC BRAKE & CLUTCH CO.

ENGINES: DIESEL, GAS, STEAM

923-In-line engines for 640 to 2150 hp

Bulletin 257 describes 4-cycle diesel, Duafuel, and spark ignition gas engines with 6 or 8 cylinders. Units may be supercharged, intercooled, or Supairthermal units. 16 pages. NORDBERG MANUFACTURING CO.

FUELS AND FIRING EQUIPMENT

924-How to disperse sludge, protect equipment

Fuel oil treatment for storage tanks and equipment is described in Data Sheet FO-157. Treatment dissolves sludge into combustible material and emulsifies condensate water to prevent rust, corrosion. 2 pages. THE NORTH AMERICAN MOGUL PRODUCTS CO.

925-Reference manual on automation in combustion

First booklet in 10-part series "Systems Engineering Applied to Combustion Control" covers automatic sequence draft control systems for stoker-fired boilers. Series will provide ready reference for combustion engineers. Those requesting current booklet will receive others in series as they are released. 18 pages. CLEVELAND FUEL EQUIPMENT CO.

926-Need a Hi-Capacity car shaker?

Bulletin 07B7221B describes features of car shaker that increases unloading volume by up to 750%. Car shaker is designed for safe, fast, and economical pushbutton unloading. Has lift bars with conveniently spaced holes to facilitate centering and make easy attaching of hooks or shackles. Car shaker is showing rapid pay out in a variety of industries including power plants, steel mills, coal mines, coal docks, and paper mills. 4 pages. ALLIS-CHALMERS MANUFACTURING CO.

HEAT EXCHANGERS

927-Compare heat exchanger costs, efficiencies

Seamless, non-ferrous Trufin S/T tubes are described in new bulletin. Includes data on shell and tube exchangers, analyzes comparable costs of Trufin and other condenser tubes. 20 pages. WOLVERINE TUBE DIV., CALUMET & HECLA, INC.

928-Data on new desuperheater

Bulletin 1037 describes recent design changes in variable-orifice desuperheater. Includes complete specifications, schematic illustrations, and a hook-up diagram showing the desuperheater as it is used in a pressure-reducing station. 4 pages. COPES-VULCAN DIV., BLAW-KNOX CO.

INSTRUMENTS AND CONTROLS

929-Why safety controls on low-pressure boilers?

Basic safety controls for all low-pressure steam boilers are reviewed in Bulletin L-711. Covers in non-technical language steam boiler operation, closed heating system, process system, single and multiple boiler systems, pumps and valves, wiring diagrams, service recommendations. Fully indexed. 24 pages. MCDONNELL & MILLER, INC.

930-Indicators for control panels

SS Series indicators for instrument control panels in cen-

This AIR-COOLED CONDENSER *produces a* HIGHER VACUUM

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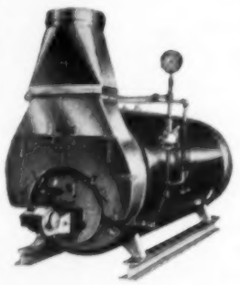

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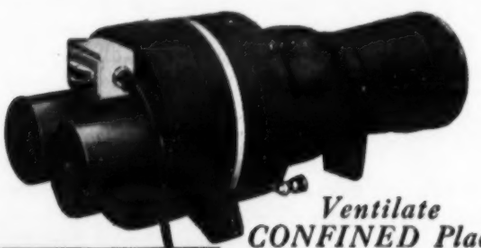
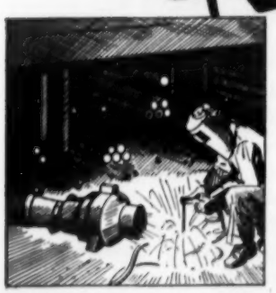


Ventilate CONFINED Places with Vano Design "C" Ventilator-Exhauster



WELDING FUMES are here removed by this Vano Ventilator-Exhauster.

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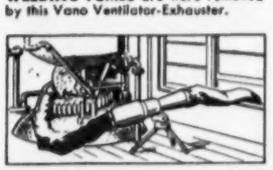

FUMES FROM A REACTOR KETTLE are here withdrawn by tripod-mounted Vano Ventilator-Exhauster. Note non-collapsible suction tubing and discharge tubing.

ANOTHER **COPPUS** "BLUE RIBBON" PRODUCT

Circle 826 on Reader Service card for more data

handy guide

. . . starts on page 40

tral stations and power plants are described in Bulletin MSP-121. Instruments measure draft, pressure, differential gas pressure and temperature, or act as receivers with pneumatic transmitters for indicating flow, liquid level, density, high pressures, or other process variables. Indicators' small size permits considerable space saving on instrument panel design. 12 pages. HAGAN CHEMICALS & CONTROLS, INC.

931-All-purpose meters for liquid measurement

Operation of nutating-piston-type meters is described in Bulletin 37. Includes data on trap strainers, air release valves, high-pressure meters, and meter registers. 20 pages. BUFFALO METER CO.

932-Mechanical specs on instruments and controls

Bulletin G15-1 gives specifications on transmitting, recording, indicating, and controlling instruments. Also covers standard control panels. Extra feature is detailed reference to other product literature available. 8 pages. BAILEY METER CO.

933-Automatic controls for central-station boilers

Carolina Power & Light Co.'s Sutton Station illustrates operation of combustion, feedwater, feedpump, and sootblowing control systems. Bulletin 1032 describes automatic boiler control systems with plug-in controllers, friction-free transverters. 12 pages. COPES-VULCAN DIV., BLAW-KNOX CO.

934-Do you have an instrumentation problem?

Handy chart in Bulletin 57-687-297 helps you pinpoint solution to your particular instrumentation problems. Instruments and controls are grouped into units for measuring pressure, flow, temperature, level, and for gas analysis. Result of measurement may be transmitted electrically or pneumatically, indicated by direct or remote reading, or recorded electrically or mechanically. Bulletin in-

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cludes mechanical specifications. 12 pages. THE HAYS CORP.

935-How to select liquid-level controls

Bulletin-1 discusses the factors to be considered in selecting a liquid-level control. Includes controls in types and sizes for handling practically any liquid, at any pressure and any temperature. 8 pages. MAGNETROL, INC.

936-Encyclopedia of controls

Thirty-four basic types of industrial temperature and pressure controls are described in fully indexed catalog. Includes self-operating regulators, water mixing equipment, pneumatic control instruments, indicating and recording instruments, control valves, pneumatic motors. Equipment is designed for process control; for heating, ventilating, and air-conditioning systems; for hot water service applications. Ninety-six pages. THE POWERS REGULATOR CO.

937-Theory of controls

Bulletin A130 covers general automatic control theory, including basic concepts of narrow band; proportional; reset; derivative; reset plus derivative; and selective control, cascade control, and ratio control. Also describes pneumatic recording and indicating controllers, data on sensing elements for measuring and controlling temperature. pressure, humidity, flow, density, etc. Forty-four pages. THE BRISTOL CO.

938-Keep an eye on maintenance with engine hour meter

Precision built, true-timing instrument is described in catalog No. 600. Both pointer-type and direct reading type can be used on all types of equipment powered by internal combustion engines, gasoline or diesel. The DC hour meter accurately indicates hours and minutes of engine operation for lubrication, oil and filter change, overhaul, and inspection. 12 pages. JOHN W. HOBBS CORP., DIVISION OF STEWART-WARNER CORP.

939-How does mechanical Btu meter work?

Bulletin 1000 describes a completely mechanical instrument that measures heat in thermal units and liquid-flow in gallons with high-precision. Meter measures heat absorbed by liquid as well as heat removed from liquid. Can be used in metering central heating and refrigeration plants. Is also adaptable for use with liquids encountered in industrial and chemical processes. 4 pages. AIR CONDITIONING EQUIPMENT CORP.

MAINTENANCE ITEMS

940-Stress rupture data on tubing steels

Bulletin TDC-153B includes handy chart giving stress rupture data on tubing steels for tubular products used at high temperatures and pressures. Lists results of stress rupture tests on 14 steels, including carbon steel, several alloy steels, and 10 stainless steels. 4 pages. TUBULAR PRODUCTS DIV., BABCOCK & WILCOX CO.

MATERIALS HANDLING (BULK)

941-Transmission equipment for conveying, lifting

Catalog 914 gives data on shaft collars, couplings, clutches, pillow blocks, take-ups, wheel hubs, gears, holdbacks, chains and sprocket wheels for elevating and conveying equipment. 88 pages. THE JEFFREY MANUFACTURING CO.

942-Do's and don'ts of chain block handling

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943-Guide to atomic energy literature

Three-section bulletin TID 4575, describes the technical information publications and services offered by AEC, and tells how and where to obtain them. Part I describes the materials and services provided by the commission. Part II sets forth methods for locating and using informational material. Part III explains how to obtain technical materials and services. 74 pages. U. S. ATOMIC ENERGY COMMISSION.

PUMPING EQUIPMENT

944-How to select precision metering pumps

Catalog 1136 describes the complete line of liquid-metering pumps with specifications to aid you in quickly selecting exact unit to do any specific job. Includes complete description of every class of pump with details on displacements and operating pressures, together with recommendations for handling specific chemicals, acids and other liquids. Volumetric conversion tables and a listing of pump components and accessories are also given. 36 pages. MANZEL DIV. OF HOUDAILLE INDUSTRIES, INC.

TRAPS, STRAINERS, SEPARATORS

945-Drain condensate automatically

Inverted open float steam traps for automatic drainage of condensate in steam lines are described in Bulletin AD-2261. Includes table of working pressures and sizes, construction and installation details. 6 pages. CRANE CO.

VALVES AND REGULATORS

946-How to protect your valves

Eleven "do's" and "don'ts" of good valve maintenance are listed in Folder DH-1303-A. Also describes 16 most common valve types and defines common valve terms. 4 pages. R-P&C VALVE DIV., AMERICAN CHAIN & CABLE CO., INC.

947-Why not try solenoid valves?

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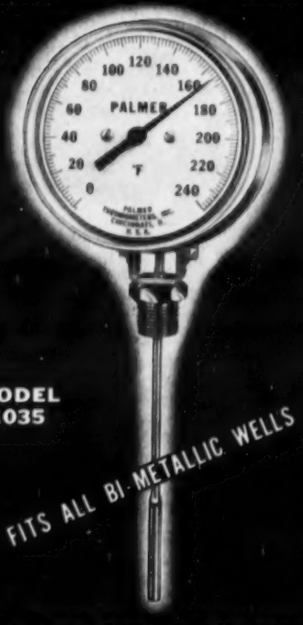

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handy guide
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to 400 F, you will want to read Bulletin V-2. Normally closed, normally open, explosion-proof normally closed valves are shown. 12 pages. THE JOHNSON CORP.

948-Reference data on gate and check valves

Catalog 57 gives engineering data and application tips on gate and check valves and fire hydrants. Covers new automatic self-sealing conduit gate valves, ball-bearing operated dry-top hydrants, corrosion-resistant valves. 244 pages. DARLING VALVE & MANUFACTURING CO.

Well, you should have stopped it before it got this far!

949-How to select diaphragm valves

Instruction details and operating characteristics of Saunders-type valves are contained in bulletin HB-6. Contains valuable sizing data and comprehensive listing of flow coefficients to aid in proper selection of valves. Includes data on prescribing diaphragm and cylinder actuators, for on-off and throttling control. 8 pages. CONOFLOW CORP.

950-Select a valve for your control system

Bulletin S-730-1 lists complete line of pressure-reducing, regulating, relief, back-presure, and control valves. Includes section on controllers, differential regulators, oil pumping unit, governors. Describes function, application, construction, and range of sizes. Lists several examples of complete control systems. 8 pages. A. W. CASH CO.

WATER SUPPLY AND TREATMENT

951-Tips on treating engine cooling systems

Technical service bulletin lists factors that influence corrosion in engine blocks. Discusses cylinder liner failure due to pitting, and impairment of cooling because of accumulation of corrosion products. Gives the characteristics essential to a good inhibitor. Includes recommended practices to control corrosion in mobile and stationary engine and air-compressor cooling systems. D. W. HAERING & CO.

MORE INFORMATION

For more detailed free information on these products just circle the key numbers on a Reader Service card between pages 50 and 51

952-Manual covers water, waste treatment

Infilco line of water and waste treatment equipment is described in Bulletin 80. Contains handy cross reference to other bulletins detailing specific equipment in municipal, industrial, sewage, and industrial waste treatment fields. 32 pages. INFILCO INC.

953-Clean boilers give better operation

Complete water treating service from initial survey to operating report forms is discussed in this bulletin. Describes treatment that stops scale, corrosion, foaming, and carryover by using correct treating compounds. Describes field test kit for quick, accurate test of water samples without knowledge of chemistry or involved calculations. 4 pages. NORTH AMERICAN MOGUL PRODUCTS CO.

954-How to supply your own water

Methods of abstracting water from the ground or by infiltration through permeable beds of rivers or other bodies of water are discussed in bulletin. Performance charts for this company's collector are supplemented with cross-sectional drawings. 20 pages. RANNEY METHOD WATER SUPPLIES, INC. ♦ ♦

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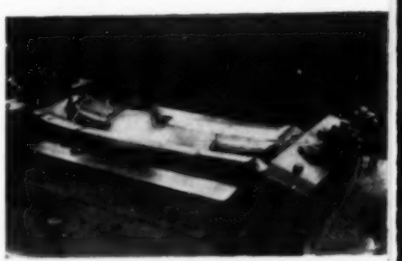
Power Pac developed for heating titanium

THE MARTIN COMPANY, Baltimore, Md. has developed a special Power Pac, using a General Electric Reactrol control, a Leeds & Northrup temperature controller and a 50-kva resistance heating transformer to resistance-heat titanium sheets to high temperature and form the metal quickly while it is still at an elevated temperature. This transformer has a 440-volt, 60-cps, single-phase primary and a 10-20-40 volt secondary. Temperature sensing is accomplished with a Rayotube sensing element, which can determine the metal temperature without coming into contact with it. Saturable reactor of the Reactrol control is connected in series with the resistance heating transformer and with a current transformer.

Reactor permits an infinitely variable control of the power transformer, while the current transformer produces a feedback signal which limits the maximum current flow through a given size of material. This special multi-tap current transformer in the feedback circuit permits a range of material sizes from .064 in. x 5 in. x 124 in. to .064 in. x 19 in. x 32 in. and .032 in. x 7 in. x 88 in. to .032 in. x 28 in. x 22 in. All sizes within these dimensions have been formed satisfactorily.

Power transformer secondary leads are connected to opposite ends of the titanium sheet. When used with the drop hammer, the Rayotube is mounted clear of the hammer, but focused on the approximate center of the sheet. When power is turned on, the titanium is resistance heated. As titanium sheet heats up, the Rayotube, detects and records the rise on the temperature controller. When temperature approaches the preset value, the "heat-up" power is reduced. Power is cut off by the operator at this point, and the forming stroke



is made. Metal must have sufficient overhang of the die so that the transformer leads can be connected by welding aluminum tabs to the detail blank in the trim area. Titanium sheet must be insulated electrically from the lower form die by coating the top of the die with a thin layer of Sauereisen. If the part requires additional forming, die is raised and whole cycle is repeated.

Power Pac has proven highly satisfactory for drop hammer forming because the proportional-type controls of the unit maintain a much closer temperature control than is possible with conventional on-off controllers. Using this Power Pac, Martin has achieved greater efficiency in resistance heating titanium. ♦ ♦

Increase steam capacity as you need it

C. B. JACOBS
Chief Plant Engineer
Swan Rubber Co.

PURCHASING PACKAGE steam generating equipment when requirements increase to meet capacity, is the policy of the Swan Rubber Co., Bucyrus, Ohio. Steam generating capacity has not been allowed to fall below steam requirements. On the other hand, the purchase of superfluous steam generating capacity has been avoided. During the past eight years, eight Cyclotherm package steam generators have been added as needed.

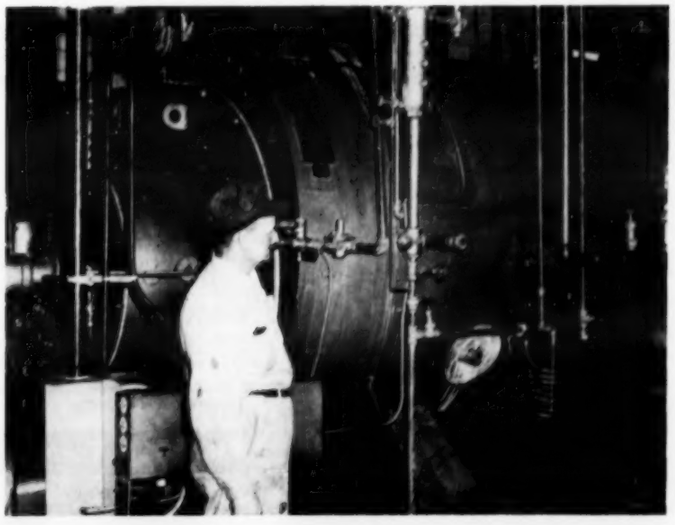
Our first package boiler was installed in 1949. It is an 80-hp unit operating at 200 psig and burns No. 4A fuel oil. It is used in the rubber reclaim plant where we recover rubber from automobile tires, foam extracts, and other sources of reclaimed rubber. Materials are pulverized, blended, mixed and devulcanized for use in the main hose plant. Steam pressure of 190 psig is required for de-vulcanizing. An additional 100-hp boiler was added in the reclaim plant in 1951 and a third unit, also 100 hp, in 1953. In 1954, we installed a 125-hp package boiler for heating our 5-million sq ft warehouse. In 1955, expansion in our plastic hose division required the installation of a 125-hp package boiler burning No. 6 Bunker fuel oil.

In 1956, major expansion in production called for a correspondingly large addition to our steam generating capacity. We put in two 500-hp, 125-psi package steam generators, burning No. 6 Bunker fuel oil and natural gas, with gas as the parent fuel. We also added another 100-hp package boiler in the reclaim plant.

All eight package steam generators have proved themselves under severe operating conditions. Combustion efficiency with either oil or gas has been maintained at a constant 80% plus. Burners require virtually no attention. The boilers swing to meet load very quickly and modulate from 30% to 100% of capacity with full efficiency through the entire range.

It can certainly be said that our eight-year experience with package steam generators has been highly satisfactory. They have enabled us to meet the constantly increasing steam requirements of a rapidly growing business without having to carry a large load of superfluous capacity along with us. ♦ ♦

For more information about Cyclotherm boilers, circle 1031 on Reader Service Card, pages 50 and 51.



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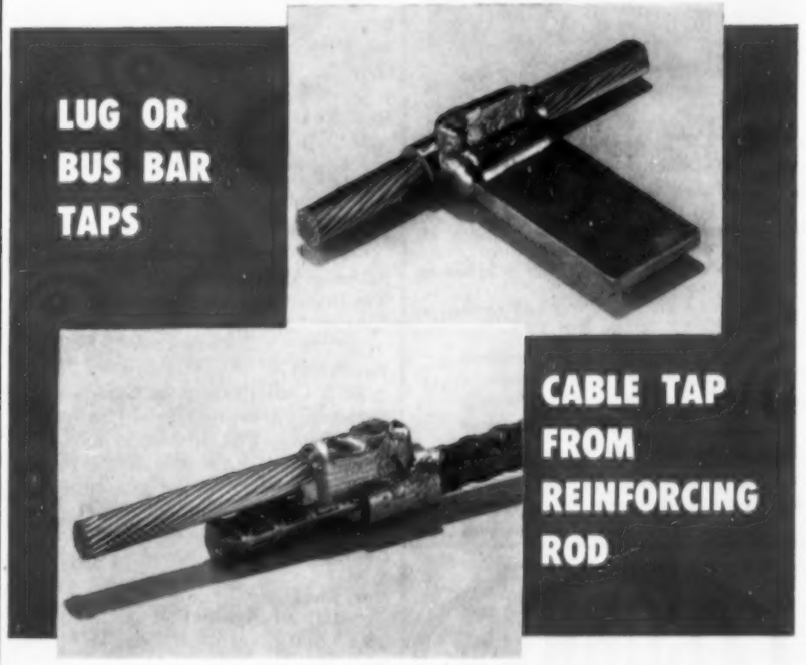

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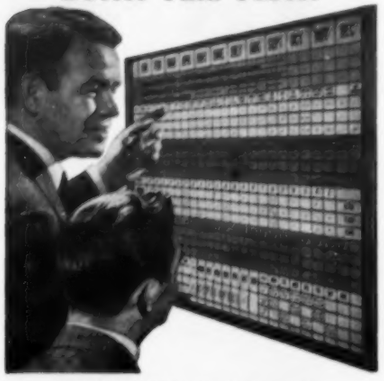

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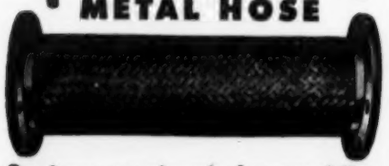

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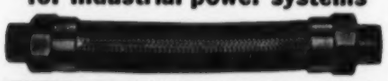

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Upcoming events

Nov. 6-8:
Edison Electric Institute Accident Prevention Committee; Penn-Sheraton Hotel, Pittsburgh.

Nov. 11-15:
National Electrical Manufacturers Association Annual Meeting; Traymore Hotel, Atlantic City, N. J.

Nov. 12-14:
NACE North East Region Meeting; Penn-Sheraton Hotel, Pittsburgh.

Nov. 13-14:
Joint Armour Research Foundation — Midwestern Air Pollution Prevention Association Conference; Chicago.

Nov. 13-15:
ASA Conference on Standards; St. Francis Hotel, San Francisco.

Nov. 14-15:
AIEE Textile Conference; North Carolina State College, Raleigh.

Nov. 14-16:
American Association of Refrigeration Engineers Semi-annual Meeting; Shoreland Hotel, Chicago.

Nov. 18-20:
National Foreign Trade Convention; Waldorf-Astoria Hotel, New York City.

Nov. 18-21:
Exposition of the Air-Conditioning and Refrigeration Industry; International Amphitheatre, Chicago.

Nov. 18-21:
Conference Board Course for Management; Westchester Country Club, Rye, N. Y.

Nov. 18-22:
American Standards Association Standardization Seminar; St. Francis Hotel, San Francisco.

Nov 18-22:
National Warm Air Heating & Air-Conditioning Association Annual Convention; Hotel Morrison, Chicago.

Dec. 1-6:
ASME Annual Meeting; Statler Hotel, New York City.

Dec. 8-11:
AIChE Annual Meeting; Conrad Hilton Hotel, Chicago.

Dec. 9-13:
AIEE Joint Computer Conference; Shoreham and Sheraton Park Hotels, Washington, D. C.

— 1958 —

Jan. 20-24:
AIEE Winter General Meeting; Statler Hotel and Sheraton-McAlpin Hotel, New York City.

Jan. 27-30:
Plant Maintenance & Engineering Show; International Amphitheatre, Chicago.

Jan. 30-31:
American Society for Engineering Education College-Industry Conference; University of Michigan, Ann Arbor.

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HP	MAKE	TYPE	RPM
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600	*G.E.	M-63456	1800
300	G.E.	M-6345Z	1200
250	A1-Ch.	ARY-626J	1800
250	*G.E.	I-M-17A-10	720
200	G.E.	I-M-16	600
200	*West.	CW-950A	514
150	Cr-Wh.	50R	1800
150	West.	CW-874C	720
150	A1-Ch.	ANY	600
125	G.E.	I-M-15A	600
125	*G.E.	I-M-15A	450
100	G.E.	I-M-E13A-4	1800
100	G.E.	I-M-14	900
100	*G.E.	I-M	720
100	G.E.	I-M-15A	450
75	North-W	EW-50	1800
75	G.E.	MT-347-6	1200
75	G.E.	I-M-13	1200
75	G.E.	MT-356-8-75	900
75	A1-Ch.	ANY-33C	720

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3 phase, 60 cycle, 220 or 440 volts (* 2200 volts or higher)

HP	MAKE	TYPE	PF	RPM
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300	G.E.	ATI-6-285M	0.8	1200
300	*Ideal	SMM	0.8	257
275	*G.E.	ATI	1.0	450
250	A1-Ch.		1.0	1200
225	Elec. Machy		1.0	360
225	G.E.	TS-6244	1.0	300
200	G.E.	TS-7559	1.0	1800
190	Elec. Machy		1.0	720
150	A1-Ch.	SYN	0.8	1200
150	*Elec. Machy		0.8	1200
150	*West	HR	1.0	300
125	*G.E.	TS-7641	1.0	514
125	*G.E.	TS-6214	1.0	277

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3 phase, 60 cycle, 220 or 440 volts (* 2200 volts or higher)

HP	MAKE	TYPE	RPM
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80	G.E.	MTC-5552	600
50	G.E.	HIC	600
35	G.E.	MTC-5536	600
25	West.	CI-636-A	720
15	G.E.	ITC-5009	900
11	West.	CI-E464-A	900
10	P & H	BW-6	1800
5	North-W	WRC	1200

PLATERS

AMPS	MAKE	VOLTS
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7500/3750	Chandy.	12/24—220/440
6000/3000	Chandy.	12/24—220/440
6000/3000	Chandy.	8/16—220/440
5000/2500	Optimus	6/12—220/440
5000/2500	Chandy.	8/16—220/440
1500/750	Chandy.	12/24—220/440
1000/500	Chandy.	12/24—220/440

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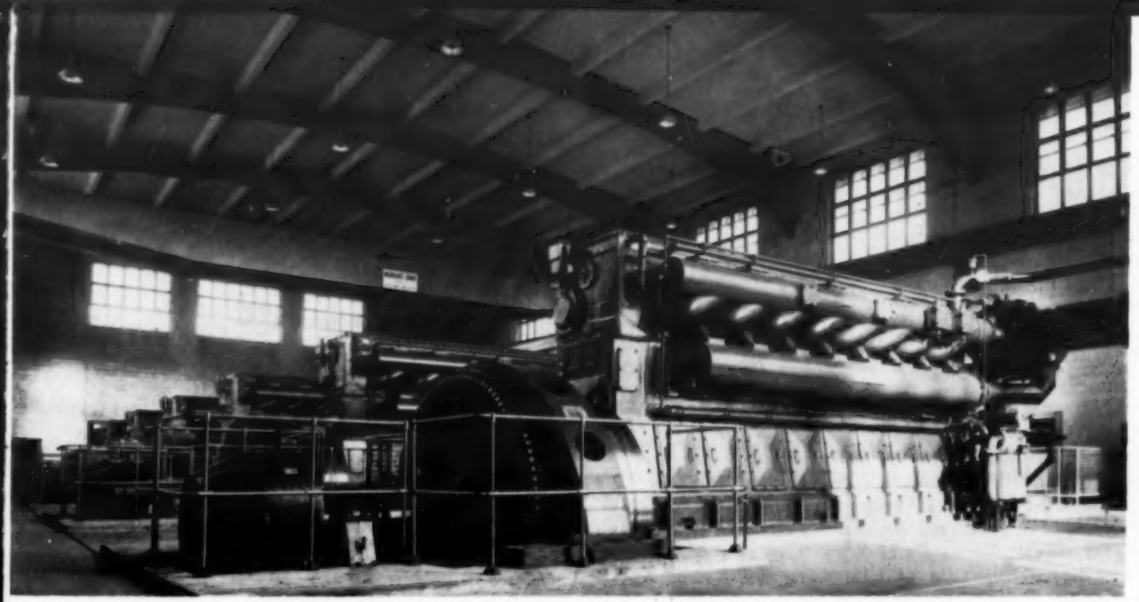

Cheaper power from digester gas

NEW YORK CITY's Owls Head sewage treatment plant is saving almost $62,000 a year by generating its own electric power from sewage gas instead of buying power from an outside source.

Nathan I. Kass, Chief of New York City's Bureau of Sewage Disposal Operations, and F. H. A. Lino, Superintendent of Owls Head plant report that "The difference between the cost of power, if purchased, and that of gas-generated power at this plant is $0.0041 per kwh. This difference represents an average saving of $61,667 annually . . ." These savings are realized by using digester gas, developed in the plant, in six Superior diesel engines that drive the generators. Engines are 8-cylinder, 14½-in. bore x 20-in. stroke.

Owls Head plant is designed to function with complete freedom from public utilities for operating power. Moreover, no provision for utility stand-by is made for operating plant equipment, all of which is electric motor driven. Thus, the engines have to be dependable.

To meet full load requirements, six dual-fuel Superior engine-generator sets were installed. Each delivers 1300 bhp, is direct-connected to 1125-kva, 4160-volt, 900-kw (at 80% power factor) generators, with direct-connected exciters.

Treatment of sewage, with the engines operating as full diesels, was begun in February, 1952. By the middle of April, digester gas was available and adjustment for dual-fuel operation was started.

Fuel oil costs for all engine purposes for the first three years of dual-fuel operation averaged only $0.0009/kwh. Daily consumption of fuel oil averaged 380 gallons. The plant generated a total of 46,100,000 kwh or about 42,000 kwh per day in that period.

"Were utility power used at this plant," Kass and Lino say, "The cost to the city would be $0.0137/kwh. This is based on the . . . prevailing utility rates and on an average monthly consumption of 1,260,000 kwh and a 2700 kw demand."

About 930,000,000 cu ft of gas with a heat value averaging 650 Btu/cu ft were used from April, 1952 to the end of 1955. For dry weather flow, averaging 85 mgd, three generating units are operated in parallel from 8 a.m. to midnight. After that, 2-unit operation is practiced.

The Superior generating units normally are operated at about 80% of capacity. But there have been times when units on the line were loaded to 110% of capacity for the short time it takes to bring in another unit. During rainstorms, an additional unit is necessary to take care of the added pumping load.

Load demands range from 2250 kw in normal dry weather full load to 1200 kw for normal after-midnight load. During rainstorms, the demand peak has reached 3000 kw.

No difficulty has been experienced in parallel operation nor in the maintenance of the 60 cps designed frequency even when as many as five generating units have been on the bus simultaneously during test runs.

In the scheduled inspection after 12,000 hours of operation, every wear point was checked. Wear was found to be far less than had been expected. Piston rings were renewed to forestall possible excessive oil consumption before the next scheduled 12,000 hour inspection, but rings removed were in such good condition that they are being carried in stock as spares.

During the heating season, there is a saving of about $36 per day because of heat extracted from the engine jacket water and from the exhaust water heat boilers. These two heat sources provide about 60% of winter requirements for building and digester heating.

It is apparent that in installations similar to Owls Head plant, where digester gas can be produced in sufficient quantities, the use of dual-fuel generating units is both feasible and economical. ♦ ♦

For more information about power from sewage gas, circle 1037 on Reader Service Card, pages 50 and 51.

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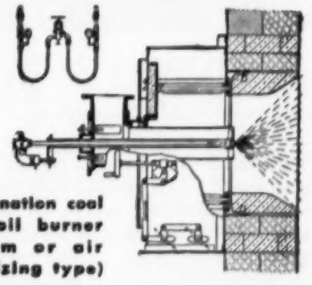
- All capacities of steam, air or mechanical-atomizing types are interchangeable

The foregoing are only a few of the reasons why Enco oil-burners have been bought by a long list of leading industrial firms. Details of how Enco oil-burners can be adapted to your present pulverized coal burners will be gladly supplied—without obligation. Write The Engineer Company, 75 West St., New York, N. Y.



Combination coal and oil burner (Steam or air atomizing type)

Combination coal and oil burner (Mechanical atomizing type)

Enco Burners

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PI news

. . . starts on page 4

rector of the U. S. Bureau of Mines, is chosen by representatives of four major national engineering societies to receive their jointly-sponsored Hoover Medal for 1957. Named after former President Herbert Hoover, (its first recipient in 1930) the gold medal is awarded "by engineers, to a fellow engineer, for distinguished public service." Sponsors are ASCE, AIME, ASME, and AIEE. Presentation will be made at the February meeting of AIME in New York.

Quarles honored by consulting engineers

Donald A. Quarles, deputy secretary for defense, is selected as 1957 recipient of the American Institute of Consulting Engineers' Award of Merit. Award citing Mr. Quarles as an "able administrator and noted scientist" was made at recent New York annual meeting of the engineering society.

ISA names Ralph Webb Honorary Member

Ralph D. Webb, (above, left) instrument department head, Union Carbide Chemical Co.'s South Charleston plant, and veteran of 33 years in the instrument field, is elected to Honorary Membership in ISA at recent Cleveland session of the group. Award is the highest honor of the society, given in recognition of outstanding contributions to the art and science of instrumentation and control.

Robert J. Jeffries, (above, right) is new president of ISA. He is assistant to the president, Daystrom, Inc., Murray Hill, N. J., and a member of AIEE, ASME and IRE. Other new officers of ISA are: Henry C. Frost, assistant chief engineer, Corn Products Refining Co., Chicago, who becomes President Elect-Secretary; Philip A. Sprague, president, The Hays Corporation, Michigan City, Ind., named vice president of ISA's General Relations department; and Dr. Ralph H. Tripp, head, instrument department, Grumman Engineering Corp., as vice president, Industries Department.

Arvid Nihlen is appointed Engineer of Manufacture for Griscom-Russell, Masillon, Ohio. Appointment is announced by K. B. Ris, president. Nihlen is a graduate of Stockholm Technical Institute and of The Royal Technical Institute, Stockholm and is a registered Professional Engineer.

Robert L. Grunewald is new Manager-Manufacturing for General Electric Co.'s Gas Turbine department. Grunewald joined GE in 1936. He is a graduate of Purdue.

Werner G. Holzbock is named Chief Engineer, Askania Regulator Co., Chicago.

Hubbard heads ASHAE Committee on sound

Arthur F. Hubbard, chief engineer, Herman Nelson division, American Air Filter Co., Inc., Louisville, Ky., is named chairman of the Technical Advisory committee on Sound and Vibration Control, American Society of Heating and Air Conditioning Engineers.

AIEE Education Award goes to William L. Everitt

Dr. William L. Everitt, dean of the College of Engineering, University of Illinois, is winner of AIEE's Medal in Electrical Engineering Education. Second recipient, Dean Everitt was named for outstanding service as a teacher in electrical engineering.

New metal measuring method developed

Measuring metal in solutions a thousand times more dilute than those analyzed previously can be done with the rapid method developed at the University of Wisconsin. Electrolytic method can measure one part of lead in five trillion parts of solution. It is so sensitive that lead absorbed into solution from glass walls of a container will upset readings. ♦ ♦

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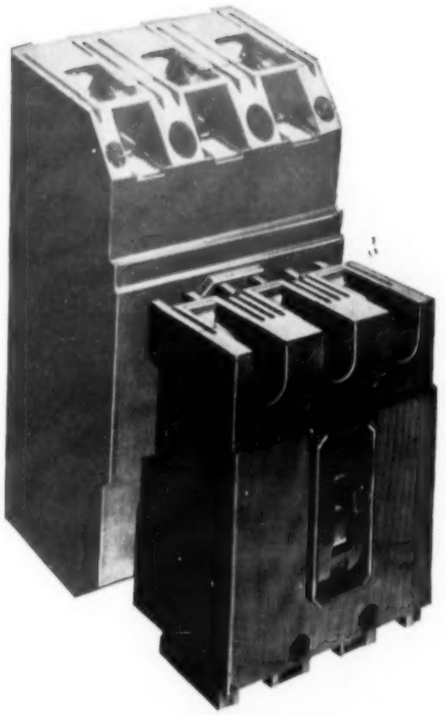

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Recognizing industry requirements for an intermediate, compact 100 amp frame 480 v breaker, I-T-E engineers have designed a new "EH" frame molded case circuit breaker which requires 40% less mounting space than breakers previously employed to meet the rating capacity.

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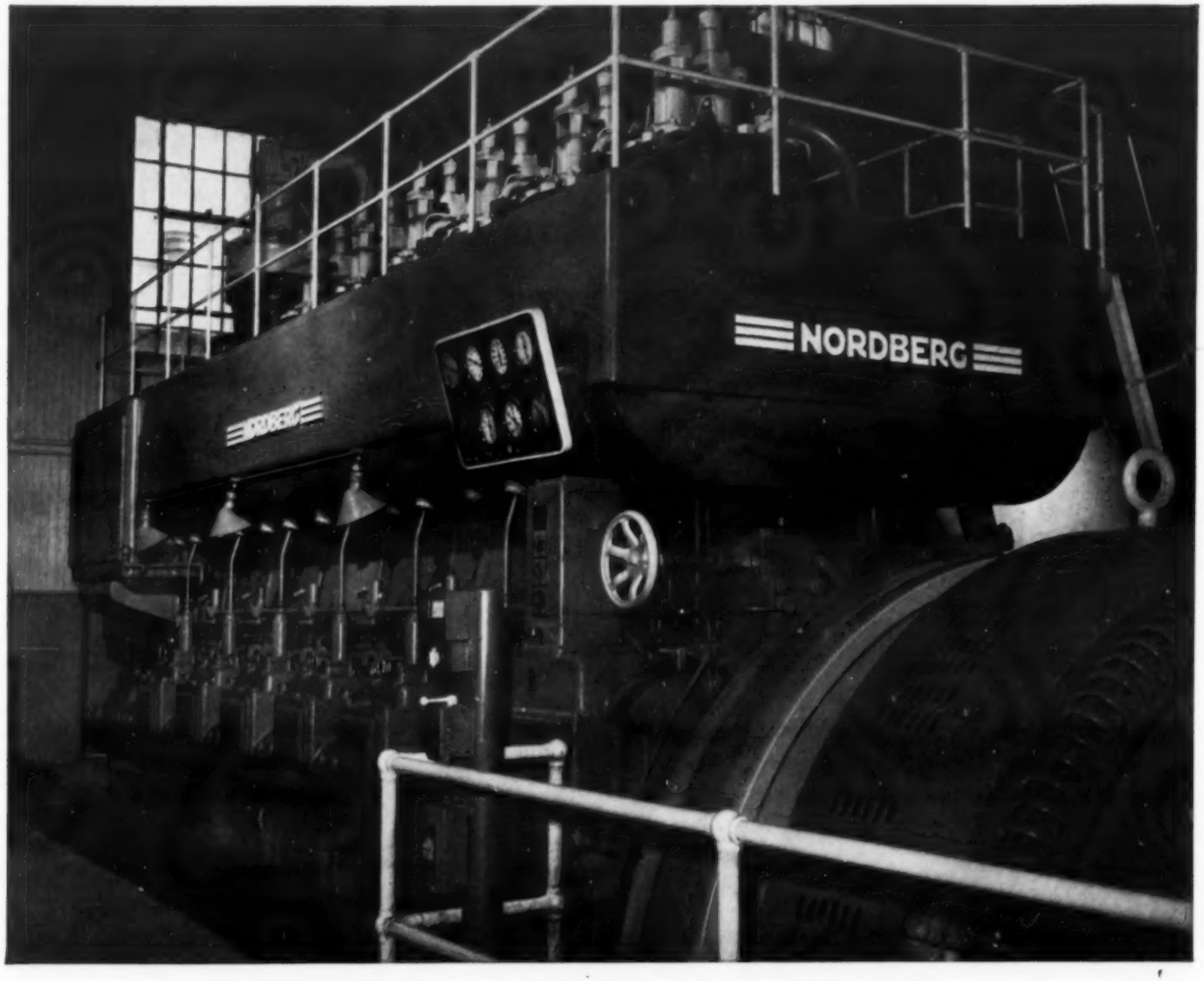

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